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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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Foundry Technical Associations.

An announcement from Sheffield, appearing on another page, indicates that a second foundry technical association is to be formed locally. In the announcement the desirability of interesting foundrymen by talking to them in their own language is emphasised, and so is the necessity for including both iron and non-ferrous foundry work. Whilst we fail to find any difference in the objects of the new society and those of the Institution of British Foundrymen, we suggest that the former may be in a better position to discuss purely local problems; but this is difficult to imagine, as the Institution caters for the local conditions by the formation of branches.

Perhaps it is imagined that the national association does not try to cater for their artisan adherents. This is not the case, as is shown by the resolution carried at the last council meeting at Manchester, which decided against holding the 1923 Conference at Paris in order that the skilled moulder might not be prevented from taking part on account of expense.

Obviously, if local associations are to spring up in the great provincial towns the Institution must place itself on a higher plane, which the bestowing of a Royal Charter implies. The Institution must be the premier foundry technical association, and the suggestion arises whether co-operation could not be assured by making the President of the Sheffield Foundry Technical Society an *ex officio* member of the Council of the Institution of British Foundrymen, thus copying the relationship which exists between the Iron and Steel Institute and the Staffordshire Iron and Steel Institute, the West of Scotland Iron and Steel Institute, and other associations.

It is useless for the Institution to imagine that it will for all time be the sole representative of foundry technology, for it is now almost customary for the large provincial engineering societies to include at least one foundry paper in their session. This year the Iron and Steel Institute had presented before them an excellent paper on Foundry Sands. Such an occurrence as the formation of a second foundry technical society brings forward most clearly the necessity for a clear statement of the future policy of the national institution. If its work is to interest the moulder, the observation may be put forward that such lectures would not interest the foreman, manager, and owner. Financial considerations are also involved. If, on the other hand, programmes are so designed as to interest the foundry controlling staff, they might not be suitable for presentation to the moulder, coremaker, furnaceman and fettler. In the direction of instructing the foundry management, there is certainly adequate scope for the Institution, even if it is confined to sound technology, without catering for the higher branches of physical chemistry, which is more than adequately dealt with by other associations.

The Institution has done excellent work in the past and will do even better in the future. The formation of a second society is in a way a compliment, for all successful associations have had "offsprings." Still, we cannot help thinking that, taking into consideration the excellent work done by the Sheffield Branch of the Institution, that it is quite capable of adequately dealing with Sheffield's wants. The branches have much latitude, and can modify their programmes to meet local needs.

British Electric Furnace Prospects.

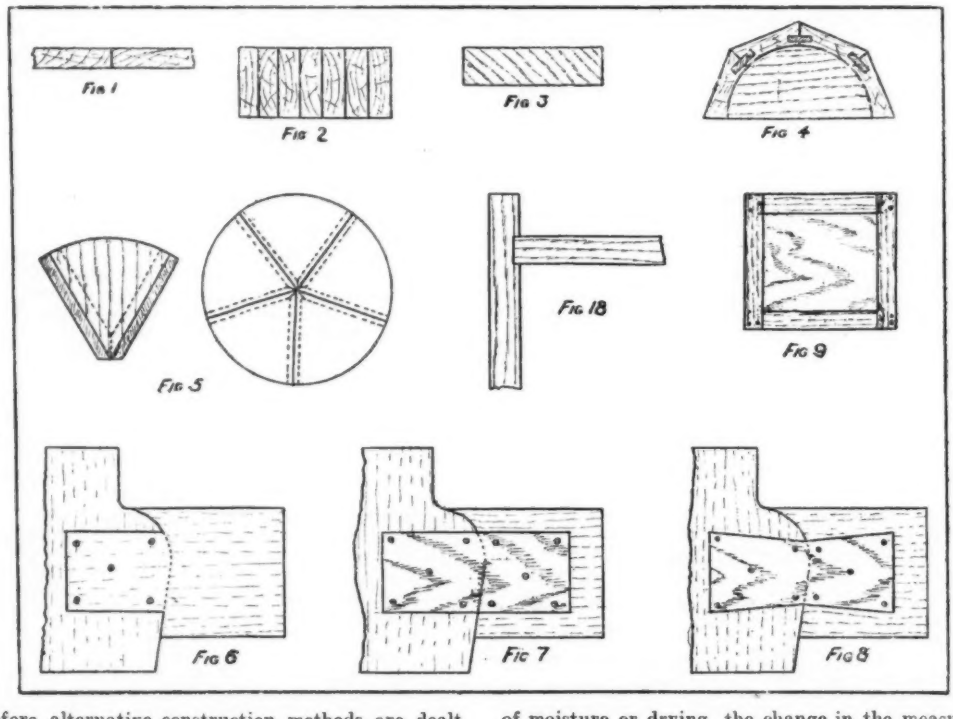
Electric steel, whether alloy or destined for castings, has suffered severely since the Armistice, the main factors being, apart from trade depression considerations, the too-rapid growth during the war period associated with the lack of supply of suitably-trained men, and in the case of the alloy-steel plants, the existence of large stocks of finished bars to be liquidated. The price of current has also seriously operated against extensive use. At the moment, however, interest is being re-awakened, and several old plants are being re-installed in fresh works. Additionally several plants are being restarted. Whilst it is advantageous to buy the latest design, it is still questionable whether high-powered furnaces give such satisfactory results as the older ones, in which the melter had to work hard to get the requisite heat.

An Apprenticeship Course in Foundry Practice—IX.

By Ben Shaw and James Edgar.

THE JOINTING OF TIMBER.

Different methods of jointing timber are adopted by carpenters, cabinetmakers, and patternmakers respectively, because of the different purposes for which the finished constructions are required, and the consequent necessary properties. The patternmaker may, and should, study elementary mechanics and graphic statics, but the knowledge will not be of value for mere woodworking, but because every patternmaker ought to be something of a designer, and in a great part an engineer; the carpenter, however, constructs with strength as the primary consideration. The cabinetmaker, on the other hand, is concerned with artistic effect, and sacrifices strength frequently to attain this. In patternmaking neither strength nor appearance are of much importance, as, consideration of how the work will deliver from the mould, and whether it will be adversely affected by the damp sand. It follows then, that, before alternative construction methods are dealt with, we must have a thorough understanding of the jointing of timber.



Face and Edge Joints.

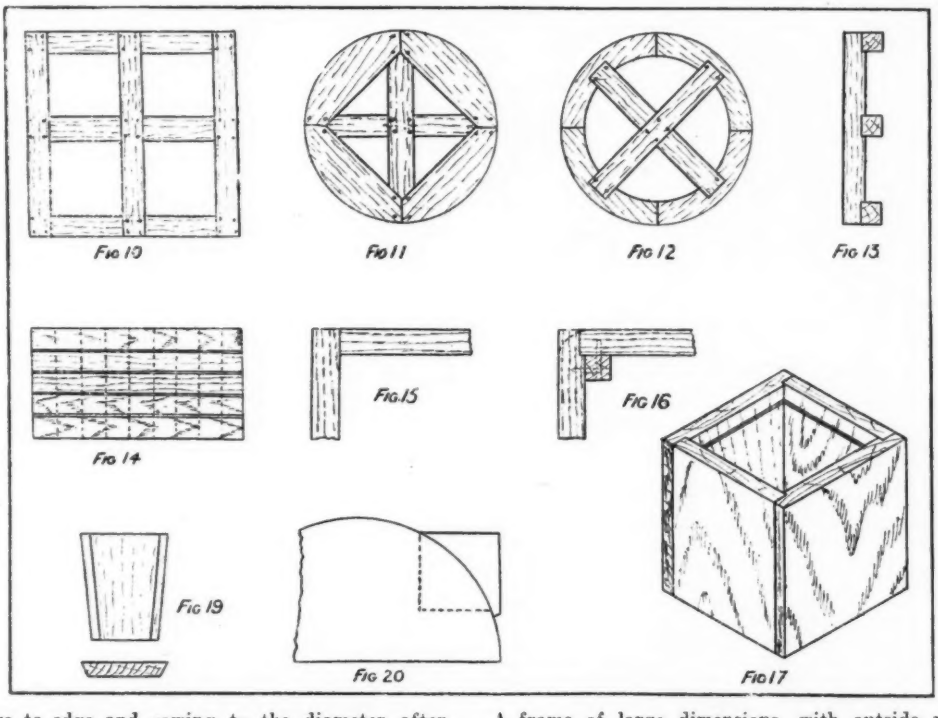
When two faces of timber have to be jointed the first operation is to get one face as straight as possible by means of the trying plane, testing with straight edge and winding strips. It is very unsatisfactory to fit a piece of timber on a twisted face. Further, there should be no chalking of joints. Chalk may be used on a straight edge for marking, but if a whole surface is chalked, the powder fills the pores of the wood and prevents a strong glued joint being made. When two pieces of timber have to be jointed the ends should be examined in order that a "back to back" joint may be made, that is, a joint with the annual rings of the two pieces tangent. The glue should be thin rather than thick, and rubbed backwards and forwards two or three times till it grips. Dogs or cramps will hold the two pieces together, or it may be advisable to insert some screws. If a glued joint has been well made the joint will be almost indistinguishable when the glue is set. If it is not intended to protect the pattern with paint or varnish, glue should not be used in its construction at all; this is an important point that cannot be too well impressed on apprentices.

For nearly all flat work the plain butt joint is used for edge jointing (Fig. 1). The edges of the pieces must be squared from previously straightened faces, being held in the vice while being planed. It is possible to get a very good joint by simply glueing the two edges together and for some work there is no alternative; but it is more satisfactory to insert dowels in the joint. If, for instance, two pieces of 1-in. timber are to be joined ½-in. holes could be bored, care being taken when marking the centres, either with gauge and square, or, by using pins, and also when boring the holes, otherwise the plate may be badly twisted. Laying ordinary pins on a piece of timber and pressing the other piece on top of them gives an indentation to the head of the pin which can be used as a centre, but it is not as accurate a method as drawing the centre. The disadvantage of a dowelled joint is that the two glued edges cannot be rubbed. Further, if swelling or contraction takes place owing to the absorption of moisture or drying, the change in the measurement of the overall size of the plate may be so considerable as to spoil the pattern. It is therefore much better to leave the joint open. This localises alterations. Open joints should be about ⅛ in. wide, and thin slips of wood, called "slivers," are used to keep the pieces apart, while the dowels are being fitted. Some craftsmen nail and glue these slivers in position thereby betraying their ignorance of the object of open joints. The slivers should always be knocked out and this applies also when battens are screwed to the boards. Such wide boards are, in nearly all cases, the bases on which work is built and thus warping is prevented when the pattern is complete. A form of jointing up for thickness, which is now largely used, and is very satisfactory, is illustrated by Fig. 2. Say a large globe valve is required and blocks have to be built up, as the pattern is not sufficiently large to employ any kind of boxed up construction, there are two ways in which this may be done. Two or three thicknesses of timber may be jointed horizontally (Fig. 2), or 1¼ in. to 1½ in. timber may be jointed vertically. If well-seasoned timber is used, and the second method is employed, the joint will always remain straight. In shapes other than diameters the advantages are even more pronounced, one of these being that if unequal swelling of the different thicknesses does occur there can be no tearing of

the mould. Some patternmakers have so much confidence in joints of this kind that they simply clamp up the block and do not use screws at all, which is very unwise as glue is never altogether reliable.

Tongue Joints.

Tongue joints are used in pattern-making, but invariably both edges are grooved, and a separate tongue inserted. It is not usual to tongue straight lengths. A much better joint is obtained, with less labour, when the tongue is a separate piece. The groove may be about ½ in. deep, and the grain of the tongue should be either quite cross or at an angle of 45 degs. with the sides, as in Fig. 3. If it is parallel with the side it does not give strength to the joint. It is common practice, when making large bushes, to make a shell pattern, staves being built on temporary grounds and separate tongues being fitted into the edges of the timber as shown at Fig. 4. The grooves can usually be sawn out at a circular saw, the edge having previously been planed to the correct bevel with the back faces. Fig. 5 illustrates another instance where tongueing is very satisfactory; it represents the plate centre of a wheel. Such a plate may be made by jointing parallel widths



edge to edge and sawing to the diameter afterwards, but the method shown has the important advantage that any shrinkage that may take place is uniform around the circumference.

The most common use of tongues in pattern-making is for fastening branches to valves or pipes. Butt jointing for the purpose is never satisfactory, as the branches frequently move when the pattern is in the sand. It is not an easy matter inserting screws that will pull in the exact direction required and there is always the possibility of a moulder loosening a part off for making up and not screwing it back in the right position. A tongue obviates this danger; if it is well fitted it should be possible to unscrew a part and replace it accurately. Separate tongues of this kind should always be made of hard wood, preferably baywood, Figs. 6, 7, and 8, show three different forms of tongues. In the case of Fig. 6 the tongue is part of the branch, and considerable care and skill is necessary to make a good job, because the tongue cannot be planed to thickness. This is the most suitable method for comparatively small branches, Fig. 7 shows a parallel loose tongue, but the dovetailed tongue, as shown at Fig. 8, makes a very fine pattern, although it takes a little longer to fit. The groove or slots for branch tongues should be roughed out with gouges, and the bottom face afterwards planed with a router. If this is done and the tongue is planed parallel in thickness and square, the pattern face will be kept straight. When the tongue is separate from the branch it is advisable to fix the main body of the valve to a level board—the drawing-board is suitable—and make the branch a correct fit after which the groove for the tongue may be drawn and cut out.

The Half-lap Joint.

In almost all patternshops frames of one kind or another have to be made, and half-lapping is common. The patternmaker does not use the mortise and tenon joint at all. A half-lapped frame is much superior to an edge to edge plate for medium size and large work, Fig. 9 shows a simple frame with a filled in centre. It is not customary to fill in the spaces between the rails, because the moulder can usually strickle these out, but in some cases it is necessary to do so, and a ledge is sawn or cut in the rails to give a "landing" for the filling-in piece. It is advisable to fill in all small frames, because it is really a simple matter, and a good surface is obtained for marking centre lines, etc. With regard to the width of rails much depends on the size of the frame, but they should be on an average from 4½ in. to 5½ in. wide, and the space between rails should not exceed 18 in. A frame of large dimensions, with outside rails only, would be altogether too flimsy for most purposes, and quite useless for use as the base board of a large job.

In order to make a half-lap frame the rabbet plane and chisel are necessary to finish the work of the circular or band saw, unless there are facilities in the pattern-shop for cutting the half-laps to a finished line by machinery, and sufficient to be done to warrant the setting of the machine. If several rails are to have the same checks cut from them they ought to be clamped together and lines squared across all the edges at one operation. In Fig. 10, for instance, the upper rails should be clamped together, and the width of the checks marked, and the same would be done with lower rails. In gauging the thickness—the rails must have been planed parallel previously—the gauge ought to be set to half the thickness, but even when care is taken in setting the gauge, slight errors occur, and it is good practice to gauge from the backs of one set of rails and the fronts of the other set. Thus if a sharp rabbet plane is used when the frame is put together very little cleaning will be required. Apprentices usually leave too much for finishing owing to lack of confidence. For thickness 1-16 in. is ample for cleaning both sides and not more than ⅛ in. across the widths. Screws should always be used for fastening the rails, although when the frame is very thin lead

rivets are to be preferred. Unskilful workmen often find when they have screwed a frame together that it is badly twisted, and this is the result of not planing the various laps parallel. It is very nearly impossible to get a frame right that has been made out of truth. The centre rail of half-lap frames should always be easy fitting because they may swell when in the sand, and if tight they will probably twist the frame.

Sometimes a circular plate is made of a half-lapped cross and segments let in as shown in Fig. 11, but this is not as good as making a segmental ring in two or more courses, and setting in the cross, as in Fig. 12. When making frames the inside positions of the rails have very often to be determined by the positions of ribs, facings, and branches, otherwise special rails may afterwards have to be fitted, which can seldom be done satisfactorily. The width of rails also depends to some extent on the details that will be fastened to it. With regard to thickness of construction frames, that is frames that are used for the inside of a boxedup pattern, no definite size can be given as much depends on the size of the work. Such frames should certainly not be less than 1¼ in. however, and should preferably be 1½ in. Construction frames like these are not always made as ordinary half-lap frames, but instead ½-checks are taken out of the vertical rails and into these the horizontal rails are set, as in Fig. 13.

An alternative to the half-lap frame for large plates is the method of crossing boards, as in Fig. 14. If a plate is required 8 or 9 ft. square, and, say, ⅝-in. thick, it is impossible to make a very strong half-lap frame, and so the crossing of 5-16 in. boards is almost a necessity, but it is not to be recommended when a half-lap frame can be made. The edge, even when open joints have been left, soon become irregular owing to side and end grain being on the same face, and the edges of the boards curl up; this necessitates the moulder doctoring the face of the mould, with the result that metal ⅛ in. or more thicker than is required may be obtained.

Corner Joints.

Not many different kinds of corner joints are made in pattern-making. There is seldom, if ever, any excuse for joining corners with a plain butt joint, as in Fig. 15. It is not much, if any, quicker than a housed joint, and inside ends almost inevitably get knocked in before the pattern has been long in use. The housed joint, shown in Fig. 16, is almost as quickly made, and is, in every way, satisfactory. When the corner has to be rounded, as indicated by dotted lines, a square block may be fitted on the inner corner to hold the ends and sides together. A typical form of construction is illustrated by Fig. 17. The sides are recessed into each other, as above described, and the top is "let in" and rests on recesses sawn from the sides. This is an ideal form of construction for the foundry, because the edges of the top—bottom when it is in the mould—cannot tear the sand when it is being withdrawn.

The usual form of corner joint for core-boxes is shown in Fig. 18. This is not adopted for appearance, as one manual the authors read some time ago explained, because appearance does not matter with core-boxes, but because it has been found to be the most suitable joint for maintaining accuracy. A plain butt joint is frequently used for large core-boxes, which is quite good, because of the constructional method employed, a matter we shall go into when discussing core-boxes. The sides of core-boxes should be at least 1½ in. longer than the housings for the ends which need not be more than ¼ in. deep.

Patternmakers' Dovetails.

With the ordinary carpenters' and cabinetmakers' dovetails the patternmaker has no concern, one reason being that accuracy cannot be guaranteed. At the same time the dovetail is much used in pattern-making, especially for fine and for standard work. When making gears the teeth are sometimes fastened to the rims with dovetails, but the most general use for them is for loose pieces. Unlike carpenters' dovetails they are tapered, as in Fig. 19, and must be made a close fit, and yet be easily withdrawn. They are invaluable for fastening facings, and bosses on vertical sides, and are usually about ¼ in. or ⅜ in. thick. At Fig. 20 a dovetail is shown as a method of holding a circular boss in position.

The Paper Joint.

The paper joint cannot be called a pattern-making joint exactly, because it is only used as a temporary expedient. It may be convenient when making small work on which there is a lot of carving to make up the body of a pattern in several pieces yet very inconvenient to screw these pieces together. If thin sheets of paper—newspaper answers the purpose—are glued and inserted, the blocks can be planed and marked off after which a chisel may be inserted at the edge when the joint will part by splitting the paper. The paper joint is sometimes used for fastening delicate work to the lathe chuck for turning.

Gazette.

THE public examination of C. W. Buttle, engineer, Birmingham, took place on August 7. The liabilities were £249.

MR. C. STARKEY, 67, Knutsford Road, and 38, Barbauld Street, Warrington, iron, steel and metal merchant, has been adjudicated a bankrupt.

IT HAS BEEN RESOLVED that the Putney Founders, Limited, be wound up voluntarily. Mr. H. H. Jeffries, 53, Peterborough Road, Hurlingham, S.W., has been appointed liquidator.

MR. A. F. WEBSTER, Denbigh House, 13, Stanley Road, Teddington, engineer, has been adjudicated bankrupt. Examination, County Court, Kingston, October 10, at 2.30. Adjudicated, September 2.

THE PARTNERSHIP heretofore subsisting between Messrs. W. Pearson, G. E. Jones, E. Heginbotham and O. Heginbotham, engineers, machinists, etc., High Street, Stalybridge, under the style of E. Heginbotham & Brother, has been dissolved.

THE CREDITORS of the Rennie Ritchie and Newport Shipbuilding Company, Limited, who met last week, decided to apply to the Court for a supervision order and to appoint a committee to represent the unsecured creditors and shareholders. The company's gross liabilities are put at £94,279, of which £43,551 is expected to rank, while the assets, after allowing for £39,169 secured on first mortgage debentures, are estimated at £103,543, or a surplus of assets of £59,992.

Personal.

THE LATE MR. J. E. RENSHAW, of Derby House, Mill Mead, Staines, ironfounder, left £1,895.

MR. W. F. IRELAND has been appointed Inspector of Factories in charge of the Wolverhampton district.

THE LATE MR. DAVID BEVAN, a director of the Grovesend Steel and Tinplate Company, Limited, left £24,088.

MR. G. ALLIN has been appointed works manager of Ley's Malleable Casting Company, Limited, of Osmaston Road, Derby.

PROFESSOR GRANVILLE POOLE, of Leeds University, has been elected neutral chairman of the Cumberland Iron Ore Mining Conciliation Board.

THE LATE MR. E. WINDSOR RICHARDS, J.P., D.L., the well-known Welsh ironmaster, left gross estate of the value of £87,811, with net personalty of £77,898.

MR. W. D'ARCY MADDEN, formerly general manager of Hick, Hargreaves & Company, Limited, Soho Ironworks, Bolton, has been elected managing director of the firm.

MR. W. A. STANIER, previously manager of the G.W.R. locomotive works at Swindon, has been appointed works assistant to the chief mechanical engineer.

THE LATE MR. A. C. WELLS, a director of the Unbreakable Pulley & Mill Gearing Company, Limited, left estate of the gross value of £82,327, with net personalty £68,034.

T. W. GREENWELL & COMPANY, LIMITED, engineers and ship repairers, of Sunderland, have placed a contract with Sir William Arrol & Company, Limited, of Glasgow, in connection with the provision of the new dry dock which is to be constructed adjoining the South Dock. The new dock will be 500 ft. long, 75 ft. broad at the entrance, with a depth of 26 ft. at H.W.O.S.T., and will be considerably larger than any existing dry dock on the Wear. The contract is for the construction of the dock entrance and 500 ft. of quay. Messrs. Greenwell are also having erected spacious new shops to meet the needs of their repairing work.

Some Notes on Moulding Sands.*

By J. H. Watson.

The importance of suitable moulding sand as a contributory factor in the production of good castings will be readily admitted by all who profess to have experience of the manufacturing side of the foundry business.

Although greater attention is being given to coke, pig-iron, scrap, and scientific cupola control, little is heard about the quality and suitability of the moulding sands which swell the total of the annual cost of raw materials.

One fact remains clear, however, and that is the general to-day, and, in many cases, modifications and improvements in the treatment of sand in the foundry are necessary.

Early Post-War Experiences.

It is necessary to point out that while these experiences refer chiefly to the production of green-sand repetition work in very large quantities, nevertheless there are general principles involved which apply to sand used for any class of moulding.

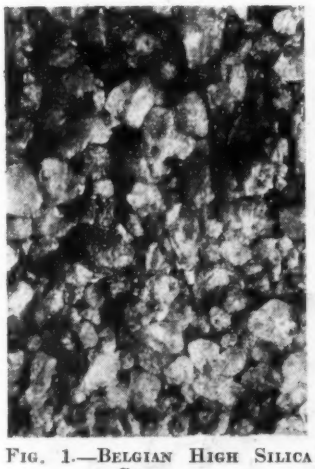


FIG. 1.—BELGIAN HIGH SILICA SAND.

FIG. 2.—BRITISH HIGH SILICA SAND.

FIG. 3.—FRENCH HIGH SILICA SAND (SILVER).

casualty list of waster castings—due either to unsuitable sand or badly misused sand—is heavy enough to warrant an attempt at its reduction.

All foundrymen desire a perfect sand, but, unfortunately, it does not exist. They very often have to make the best use of what they have been accustomed to use for many years. Do they always make the best use of British moulding sand supplies? This is very questionable, and the writer's endeavour is, if possible, to arouse interest in this direction.

It has been the author's experience, along with others, to have had periods during which the production of nice, clean-skinned castings left nothing to be desired; and when the percentage of wasters through such causes as "drops," "scabs," etc., were at a happy minimum. Then there are periods when nothing seems to go right; the sand is wrong, the metal too hot or too dull; moulding not as it should be—in short, there are quite sufficient reasons to allow of one having a generous diversity of choice.

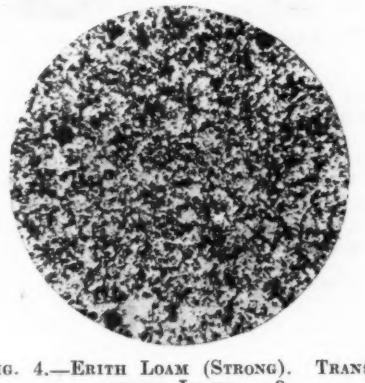


FIG. 4.—ERITH LOAM (STRONG). TRANSMITTED LIGHT × 8.

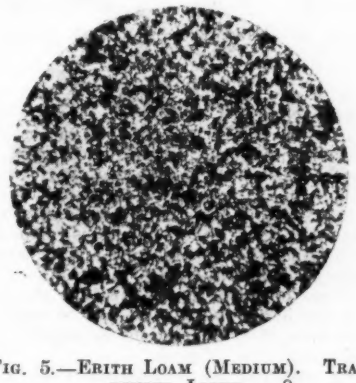


FIG. 5.—ERITH LOAM (MEDIUM). TRANSMITTED LIGHT × 8.

BOTH HAVE BEEN REDUCED SLIGHTLY ON REPRODUCTION.

Broadly speaking, foundrymen desire a sand which, after the exercise of normal moulding skill, will give (1) a clean impression of the pattern; (2) withstand flow of molten metal until mould is filled; (3) strip freely and leave a clean, accurate casting. These requirements sound simple, but to attain such results in actual practice and with some degree of regularity calls for a deeper knowledge of the properties of moulding sand than is

The remedying of most foundry troubles resolves itself largely into a question of elimination, and with this in mind the writer decided to prove or disprove, if possible, any accusations directed against the sands in use. Seeing that moulding sand is the initial raw material used in the production of the finished article, it was considered this should be a legitimate object for first consideration.

During the period subsequent to the Armistice the author was using red sand from How Mill and rotten rock sand from Boldon. The latter appeared

* A Paper presented before the Newcastle Branch of the Institution of British Foundrymen.

good for cores, but did not appear to be sufficiently strong or refractory for the then current moulding purposes, which was an output of repetition green-sand castings amounting to 400 or 500 tons per week. The How Mill sand did not appear sufficiently refractory. It contains a considerable amount of mica in small, thin flakes.

Later it was possible to obtain supplies of Erith loam, which was previously in general use throughout the whole of the works, and an improvement of skin was visible. However, scabbing and dropped tops were sufficiently frequent to cause worry, and the skin of the castings was not consistently good.

The mixing of sand for ordinary jobbing work was left partly to the moulders and partly done by labourers; but as regards the repetition work foundries mixing was carried out by labourers solely.

Use and Abuse of a Good Sand.

When using Erith loam it was noticed that some days the castings had a very good skin, other days the skin was poor. Apparently with the same sand it was possible to get good or bad results.

After investigation it was decided that the system of mixing the sand could be improved. Definite quantities of burnt sand, fresh loam, and coal dust were mixed, milled and riddled before being passed to the foundry. Some attempt was made to control the amount of water used in tempering the sand. A new and improved impact coal grinder was installed, which gave an abundant supply of finely ground coal.

The net result of this change was a decided improvement in the skin of the castings, which has been consistently maintained.

The point so far is that with an admittedly good sand, such as Erith loam, the best results had not been obtained owing to imperfections in the system of mixing. Before condemning any sand it is advisable to pause and consider whether we are giving it an opportunity to function at its best. On the other hand, it is just as well to realise that all sands have their limitations as regards use for any and every class of work.

Having obtained an improvement by altering certain methods of treating the sand, the next step was to discover *why* such a change in treatment gave better results. This will be shown later.

Origin of Sand and Typical Composition.

The geologist assures us that the origin of all sand may be traced to the granitic rocks forming the earth's crust after solidification took place. Granite is composed of the following minerals:—Quartz crystals, 50 to 60 per cent.; felspar, 30 to 40 per cent.; mica, about 10 per cent.; and frequently traces of iron. Quartz is, of course, pure silica, SiO_2; felspar is made up of orthoclase ($K_2O.Al_2O_3.2SiO_2$) and anorthite ($CaO.Al_2O_3.2SiO_2$); and mica is mainly $KNa.H_2.Al_2(SiO_4)$.

During the immense periods of time subsequent to solidification the granite has been broken down into its constituent minerals by natural agencies. The quartz crystals, though altered in shape and size, remain unchanged as regards composition.

Part of the mica and felspar also remain unchanged chemically, whilst a portion decomposes into simpler compounds containing lime, soda, potash, alumina, and silica.

Moulding sand may be defined as a substance consisting essentially of grains of quartz, varying in size from coarse to exceedingly fine, and in shape from rounded to angular, associated with a very fine clayey material (pure china-clay—$Al_2O_3.2SiO_2.2H_2O$) and hydrated oxide of iron (limonite—$2Fe_2O_3.3H_2O$): also mineral particles containing lime, soda, and potash.

The particular use to which the sand may be put depends upon the relative proportions of these three classes of mineral ingredient. High silica sand is composed almost entirely of quartz grains. The absence of clayey material renders necessary some artificial bonding material before it can be used for moulding purposes.

The amount of clayey material and oxide of iron (*i.e.*, bonding materials) accounts for such differences in strength as mild, medium, and strong varieties of loam. Size of grain has also an influence on strength.

If the minerals responsible for lime, soda, potash, which exercise a fluxing influence, are present in excessive quantity, its refractoriness is reduced, and a tendency to stick to castings of thick section may be observed. This, however, can be greatly minimised by the use of a suitable refractory facing.

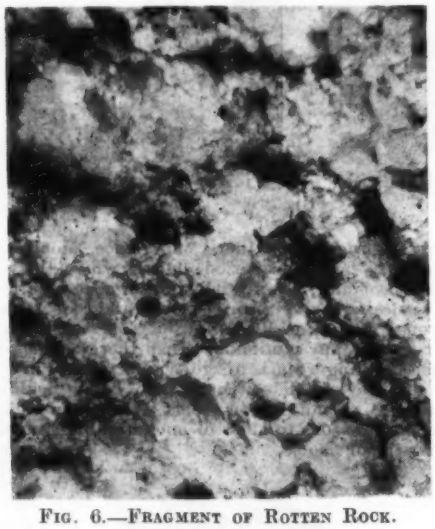


FIG. 6.—FRAGMENT OF ROTTEN ROCK.

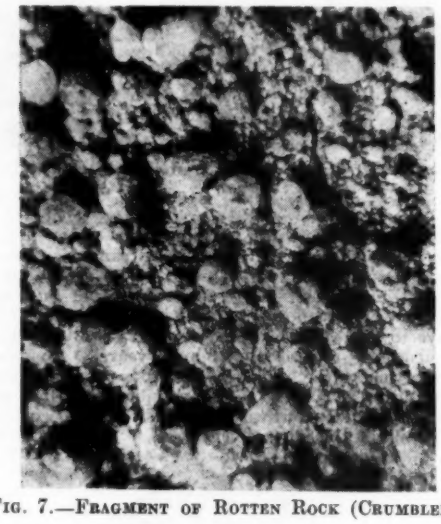


FIG. 7.—FRAGMENT OF ROTTEN ROCK (CRUMBLED).

For purpose of comparison, the analyses of a naturally bonded moulded sand and a high silica sand are given below:—

Hutton's Ambo No. 3. Erith quality.

	Per cent.	
SiO_2	86.8	
Al_2O_3	6.45	
Fe_2O_3	1.55	
CaO	0.45	2.11
K_2O	1.5	
MgO	0.16	
TiO_2	0.197	
Loss on ignition	1.7	

Hutton's Ambo No. 15. High Silica.

	Per cent.	
SiO_2	95.7	
Al_2O_3	1.7	
Fe_2O_3	0.35	
CuO	0.10	0.96
K_2O	0.60	
Na_2O	0.10	
MgO	0.16	
H_2O (above 105° C.)	0.80	

Essential Properties.

The chief properties which enable a sand to function successfully are as follows:—(1) Refractoriness; (2) venting qualities; (3) strength of bond; (4) size of grain.

Refractoriness.

From the view-point solely of resistance to high temperature, the higher the percentage of quartz grains, *i.e.*, silica grains not in chemical combination with any other mineral, the more refractory the sand. This is accounted for by the fact that the melting point of quartz is about 1,700 deg. C. (U.S.A. Bureau of Standards), which is considerably above the casting temperature of cupola-melted iron. (Hot iron is at the temperature of 1,350 deg. C according to Hatfield).

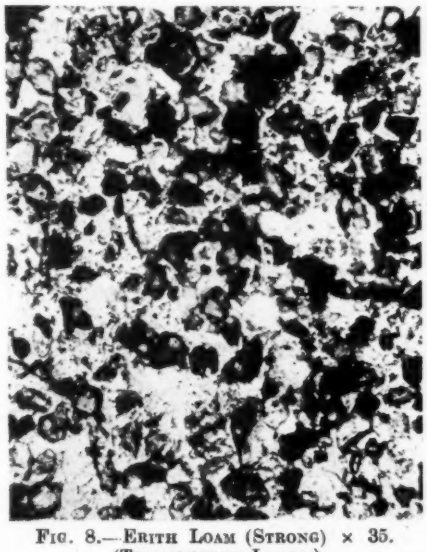


FIG. 8.—ERITH LOAM (STRONG) × 35. (TRANSMITTED LIGHT.)

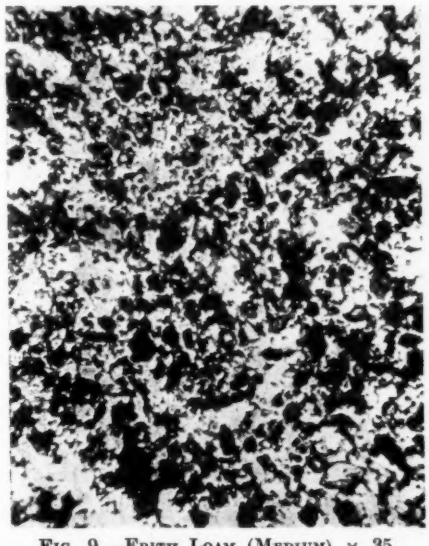


FIG. 9.—ERITH LOAM (MEDIUM) × 35. (TRANSMITTED LIGHT.)

BOTH HAVE BEEN REDUCED SLIGHTLY ON REPRODUCTION.

There is a common impression that a sand showing on analysis a reasonably high-silica content will be refractory sand. Though silica is the commonest constituent of rocks, it is most frequently in chemical combination with other substances, *e.g.*, lime, magnesia, soda, potash, etc., and, combined in this way and forming as it does a mineral ingredient of moulding sand, it does not possess the same degree of refractoriness as when in the free or uncombined condition—*i.e.*, when it is present as quartz. Hence, if such minerals as felspar and mica, which contain silica combined with lime, soda, and potash, are present to any great extent, the heat-resisting qualities of the sand will be lowered accordingly.

Chemical analysis may not be possible to all who may desire to attempt in a modest way to investigate the sands they are using. If not, there is no need to be disheartened. Apart from chemical analysis, the use of a good hand lens, or, better still, a microscope is a very great aid in the detection of quartz grains, and some of the commoner minerals such as felspar and mica.

This latter instrument need not possess research qualifications. The author has spent many interesting and profitable hours with an instrument which cost only 50s.—post-war price.

This is mentioned by way of comfort to any foundryman who may be inclined to wilt at the mention of a microscope.

The remarks made regarding free silica (quartz) and silica in combination with other substances and the effect upon the refractory quality of the sand, apply also to the clayey matter present. Pure clay (Al_2O_3, $2S_1O_2$, $2H_2O$) softens about 1,740 deg. C. (U.S.A. Bureau of Standards), but the softening point may be considerably lowered by the presence of such fluxes as lime, potash, etc.

The simplest illustration of the lowering of individual refractory capacity is to be found in ordinary cupola working, where lime, with an individual melting point of 2,570 deg. C. and sand, ash, etc., with a melting point of, say, approximately 1,700 deg. C., form a fusible fluid clay at normal temperatures, the highest of which, even on extremely hot metal days, falls considerably below the melting point of sand, *i.e.*, the material with the lower melting point of the two.

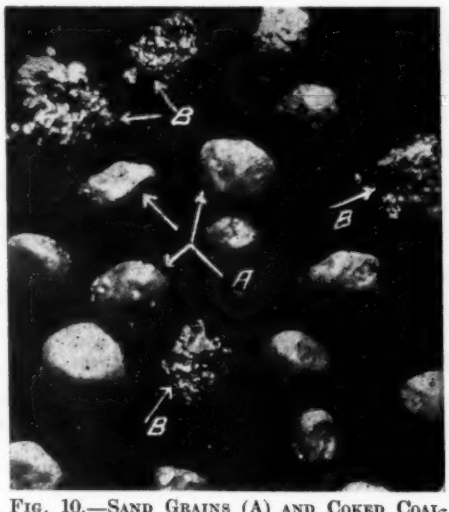


FIG. 10.—SAND GRAINS (A) AND COKED COAL-DUST PARTICLES (B) FROM MOULD FACE.

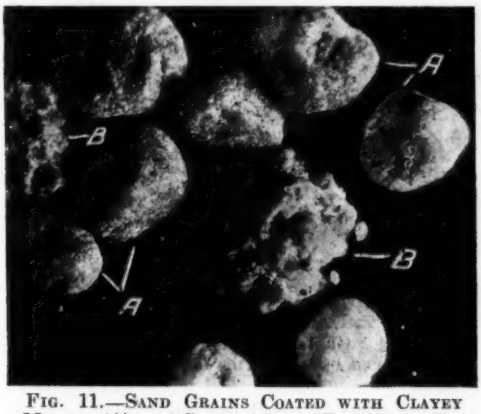


FIG. 11.—SAND GRAINS COATED WITH CLAYEY MATTER (A) AND CONGLOMERATE PARTICLES (B).

While the temperature of molten cast iron makes no such severe demands upon a sand as molten steel, frequently castings of heavy section have the sand "burnt on." This is very likely to happen where "hot" metal is the practice—and where is it *not?*—even when the section is not particularly heavy. The advantage of using a suitable artificial refractory facing becomes apparent in such cases.

The true reason for using graphite, plumbago, blacking, etc., as a mould facing is to render the sand particles more refractory by coating their surface with highly refractory material. This protective casting largely eliminates burning on of the sand, and produces a good skin. An actual

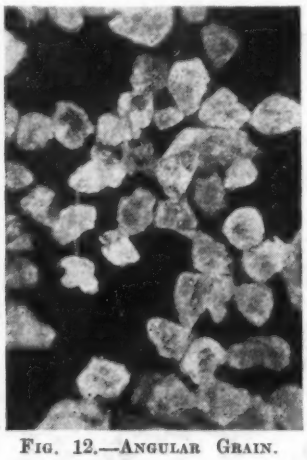


FIG. 12.—ANGULAR GRAIN.

trial of two moulds, one with and one without such protective facing, and using fairly hot metal, will furnish proof of a very conclusive nature. Coal dust functions in a similar manner as regards its part in producing a skin.

If a portion of a mould made of sand, to which coal dust has been added, be examined after stripping from a casting, the surface of the mould and the individual sand grains are found to be coated with a very fine shiny deposit of carbon. This deposit makes the grains of sand more refractory, and assists very greatly in obtaining clean stripping and a good skin. Too much coal dust weakens the strength of a sand, and is liable to produce sand cracks, which leave a veined marking on the castings.

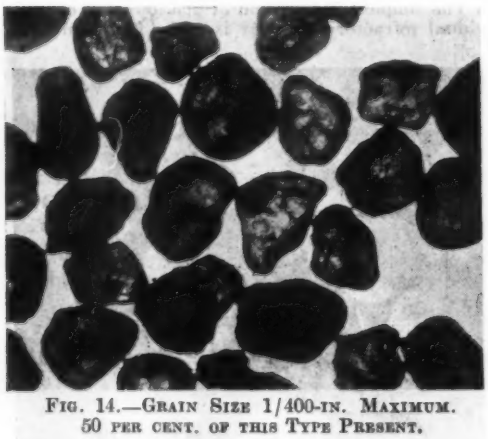


FIG. 14.—GRAIN SIZE 1/400-IN. MAXIMUM. 50 PER CENT. OF THIS TYPE PRESENT.

In the event of a coal shortage it may be necessary to obtain a substitute for coal. Creosote oil, ground pitch and tar are very satisfactory so far as producing a skin is concerned, but the fumes are dense. Sawdust is a cheap substitute, but the quantity required interferes seriously with strength of mould.

Venting Qualities.

However hard rammed and closely packed together sand grains may appear to the unaided eye, there is an appreciable space area remaining.

To better illustrate this, suppose thirty-six halfpennies to be laid down into a 6 in. square; they could not be packed any closer unless made to overlap each other.

The actual area covered by the coins represents, in round figures, 80 per cent. of the total, and the balance of 20 per cent. may be termed "open space." Making allowance for the fact that sand grains are not flat discs like coins, but may vary from spherical to angular shape, it is evident that a certain amount of space area will be available by means of which it will be possible for the mould to vent itself naturally.

This natural venting capability will depend upon (1) the type of grain, whether rounded or

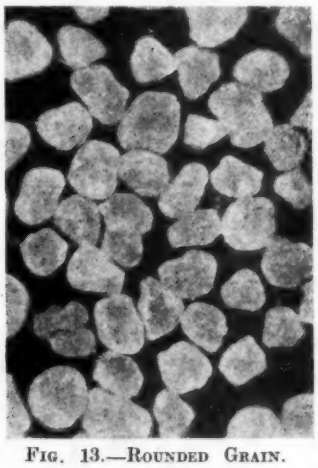


FIG. 13.—ROUNDED GRAIN.

angular, also whether the prevailing grade be course, medium or fine; (2) the amount of clayey matter and excessively fine particles present in all naturally bonded moulding sands; (3) the amount of water used to temper the sand.

Broadly speaking, the coarser the grain the better the venting quality of the sand. At the same time, it must not be forgotten that if there is a large amount of clayey material and fine silt present this small stuff will fill up part of the space area of the mould and diminish its venting capabilities. Too much water in the sand has a similar influence, and this added defect, *viz.*, excessive generation of steam, thereby further taxing the venting capability of the mould.

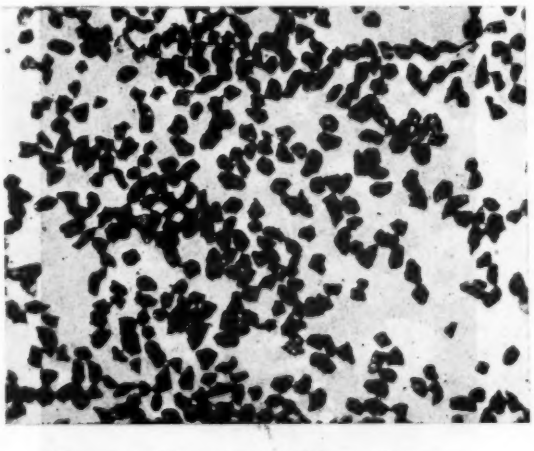


FIG. 15.—GRAIN SIZE 1/200-IN. MAXIMUM.

While dealing with the question of venting qualities, the following experience may be of interest:—Troubles from scabbing arose amongst a certain type of casting which is produced in large quantities. If the mould was rammed hard scabbing was very prevalent. On the other hand, if slack ramming was resorted to, the castings gauged very badly. The gauging allowances were not too generous, and the difficulty was further accentuated by the fact that their manufacture was carried on by semi-skilled labour.

By reducing, and in some cases eliminating, Erith loam, and using a coarser grade of sand, the foundry was enabled to reduce scabbing to a minimum, and also obtained much greater latitude as regards individual variations in ramming; in fact, instructions were issued to ram the moulds fairly hard. The gauging also was very greatly improved. The change was made by introducing Hutton Ambo sand at first, but later we obtained a much cheaper and quite satisfactory sand from Boldon, Co. Durham.

Strength of Bond.

What the bonding quality of a sand really means from the view-point of practical utility is best realised by considering how the millions of particles in a green-sand mould adhere to each other and retain the pattern outline after the support of the pattern is withdrawn.

A high silica sand or sea sand will, after being wetted, retain simple shapes, *e.g.*, the sand pies of seashore fame, but such shapes will hardly bear touching without collapse. The peculiar property of a moulding sand is due to other than a mere wetting of the grains. Oxide of iron and the clayey matter present in the sand possess the property of absorbing water, and by so doing become sticky or possessed of adhesiveness. Usually the sand grains are coated with a thin film of oxide of iron and also clayey matter which, on moistening with water, enables the grains to hold together much more tenaciously than is possible in the case of a moist high silica sand, where the very slight adhesiveness is due only to the surface tension of the water.

The amount of water which may be added to temper a sand correctly varies considerably with different sands. It is not, however, a difficult matter to determine the most suitable proportion for any sand which may be in use, and well worth a little trouble, for instructions can be given as to quantity required with each mixing, and the frequently misplaced generosity of some individual with a bucket or hosepipe be curtailed.

After a batch of moulding sand has been moistened by a suitable addition of water, such operations as mixing, riddling, and milling are found to strengthen the sand considerably. By such processes, the bonding materials present are well distributed throughout the bulk of the sand and the grains become more thoroughly coated with such adhesive material. The tempering water is also much more uniformly distributed if these operations are thoroughly performed.

In certain cases, a sand which apparently possesses a low degree of bond strength can be made stronger to a surprising degree by thorough milling. This is due largely to the distribution effect previously mentioned, and also to the breaking down of small knotty masses about the size of very coarse grains, and which are in reality composed of a number of fine grains bound together like fragments of sandstone rock.

Grain Size.

Messrs. Hanley and Simonds, in *The Foundry* of Sept. 15, 1920, rightly emphasise the importance of grain size in relation to the amount of bonding material present. "The strength of bond is influenced by the surface area of the sand." That is to say: it does not inevitably follow that in two moulding sand samples, the former containing a higher percentage of bonding material than the latter, that the first will have the greater bond. Grain size must be considered. A small grained sand has a bigger total surface area than a coarse-grained variety. If, therefore, that with the smaller grain contains a higher percentage of bonding substance, it must be remembered that it has to be spread over a larger surface.

A further point to be considered in respect of grain size is the fineness of skin required on the casting. A coarse sand may be used on castings which are not required with a good skin, pig iron for example. For fine work, naturally a fine smooth sand is required, and this applies particularly to the making of metal patterns. The venting and bonding properties must, however, be kept in the foreground if consistent results are desired.

In conclusion, the functions of a good moulding sand can be summarised as follows:—

1. To retain a clean impression of the pattern. (a) It is necessary to have the requisite natural bonding materials present and make full use of this property of the sand by correct proportioning of water and suitable mixing, milling and riddling. (b) Choose a sand having a grain that will leave a smooth clean mould skin.

2. To withstand flow of metal until mould is full. (a) A sand is required that will stand good sound ramming without packing so close as to fail to carry off gases and steam. (b) Possess sufficient strength of bond to prevent peeling, cracking, washing, buckling, etc.

3. To strip freely and leave a clean casting. By suitably coating the grains of sand with an artificial refractory so as to assist or augment the natural refractoriness of the sand in immediate contact with the molten metal, and prevent burning on of sand particles.

DISCUSSION.

MR. YOUNG, in opening the discussion, said Mr. Watson had mentioned that his Paper was elementary. Mr. Watson had had a great deal to do with sand, and where real "experience" is concerned the word "elementary" did not apply.

MR. WISE said he thought that the moulding quality of a sand could only be found out by actual practice in the shop, but as regards the quality, the chemical analysis could be a great help to the average foundryman. He wished Mr. Watson had spoken about oil-bonds as well as clay-bonds, as a great many difficulties could be eliminated by the use of oil-bonded sand.

MR. GALLON said that in green-sand moulding it was very essential to mix the sand with a certain amount of coal dust, and he would like Mr. Watson to give the amounts of coal dust in the particular sands, and also the results of adding such quantities. One could take a handful of sand and squeeze it together, and by looking at it tell whether it was a good moulding sand or not, but one could not tell how much coal dust it contained. If the quantities of coal dust and blacking were given they would be helpful to men who have not had a chemical education.

MR. FRIER asked whether the lecturer was in favour of the Erith loam. He thought that in foundries where green-sand and dry-sand work had to be carried out close together it was best not to have too many kinds of sand.

MR. OAKFORD asked whether it was possible, when making large quantities of repetition castings, to avoid the use of facing sands. Concerning the question of sand-treatment, there are many expensive ways of dealing with the sand, but we needed to find a method of dealing with it cheaply in large quantities. He considered more of the old sand in foundries should be thrown away and replaced by new sand, the latter being cheaper than defective castings.

MR. C. GRESTY asked what were the relative advantages and disadvantages of naturally bonded sands and artificially bonded sands.

MR. YOUNG said that the lecturer had brought up the question of sand of different sized mesh, but did not mention what sizes. He would also like to know whether Mr. Watson had found that coals with different ash-content gave different results. He considered the adherence to one particular type of foundry sand was largely due to lack of knowledge, and if people had a good look round they might find some cheaper and, perhaps, better.

The Author's Reply

Replying to Mr. Wise, the lecturer said it was profitable for all to make their own tests, and if a foundryman had found a good sand he advised him to keep to it. It was quite a simple matter to find out the grain of a particular sand by the use of a set of sieves. He had confined his remarks to the sands which he had had the most experience with.

With regard to the quantity of coal dust used, Mr. Watson said that the idea of his Paper had been to give the lines on which he himself had worked. When one had a sand which gave good results, the next thing to do was to look round and see if there was a cheaper sand which would give equally good results. If a fine skin was wanted on a casting the quantity of coal dust

would have to be increased. The job had to be considered before the amount of coal dust could be fixed, but by all means work with a minimum.

He did not pin his faith to any particular sand, but rather chose one which could be obtained without unnecessary railway expenses. It is preferable to work with only one or two types of foundry sand.

He (Mr. Watson) advised Mr. Oakford to try the repetition work without the use of facing sands, but the results would not be so successful, and one has to consider reputation as well as expense. The handling of sand can be done cheaper by hand in certain cases, but for large production work it is best to have some kind of mechanical arrangement.

It is often essential to add fireclay to sand on account of the sand being too refractory, but it is advisable to use a naturally bonded sand when possible, because it will work out cheaper.

If a coal high in ash and slatey material is used the castings are inclined to look rather grey, and where there is only a few shillings per ton difference between two coals it pays to get the better one, as a much better skin can be obtained on the castings.

A hearty vote of thanks was then given to Mr. Watson for his lecture, and also to Mr. Patterson for the permission accorded to Mr. Watson to publish the information obtained at his works.

Diminution of Lag at Arl through Deformation.*

By J. H. WHITELEY.

(*Abstract.*)

Evidence of lag in the crystallisation of pearlite, particularly in hypo-eutectoid steels, is derived from several considerations. It is found in the well-known fact that, for a given steel, the temperature of the Arl transformation is not constant but is lowered as the rate of cooling is increased. Again, since the presence of carbide nuclei within the γ-iron areas induces crystallisation of the carbide and ferrite as globular pearlite at a temperature considerably higher than that at which growth takes place in the absence of such nuclei, lag must clearly occur in the latter case. In the experiments described below, two methods of deformation were used, namely, hammering and bending.

A small electric furnace, containing a silica tube 1 in. internal diameter, wound with nichrome wire, was placed vertically on a block of steel, resting upon two supports. A bar of hard chrome steel, ½ in. square section, was used as an anvil, and between it and the block was a thick pad of asbestos board. A thermo-couple, passed through a hole drilled in the block, was so placed that the temperature of the furnace at the surface of the anvil was recorded. A rod of manganese steel was used to transmit the hammer-blows to the specimen on the anvil.

(1) *Deformation by Hammering.*—In this experiment the steel consisted of a piece of ordinary mild-steel plate which had been allowed to cool in the centre of a solidifying slag ball; the normal banded structure was thus eliminated and an approximate uniformity in composition obtained. The Ar1 point had previously been found, by quenching specimens, to lie between 685 and 690 deg. C., and Ac1 between 715 and 720 deg. C. Two small sections, differing in shape so as to be easily distinguished, each weighing about 1.0 gramme, were placed on the anvil, and the rod placed on the adjacent asbestos packing. The temperature was raised to 900 deg. C., and then lowered in about ten minutes to 695 deg. C. After the pieces had remained at this temperature for fifteen minutes, in order to give time for equilibrium conditions to be established, the rod was carefully placed on one of them and a smart blow given with a hammer. During the next ten minutes the temperature was kept at 695 deg. C. and the above procedure repeated, in varying order, about six times, and after a further five minutes the specimens were rapidly quenched in water. The deformation made by hammering in this way was found to be comparatively small; the same experiment was done several times, and in no instance was the depth of the piece (3-16 in.) reduced more than 1-40 in.

The results obtained from the repeated experiments all agreed. They showed unmistakably that lag at Ar1 could be diminished by slight deformation.

(2) *Deformation by Bending.*—The same apparatus was used in this experiment. In order to bend the specimens a V-shaped notch ¼ in. deep was cut in the top of the anvil, and the end of the rod shaped like a chisel. A strip ½ in. by 3-16 in. of steel sheet, 1-16 in. thick, of similar composition to the steel used previously, was placed across the notch, heated to 900 deg. C., and cooled to 695 deg. C. When the piece had remained at 695 deg. C. for fifteen minutes, the rod was placed upon it so that the end was in line with the notch and two or three light blows were then given with a hammer. The strip was bent in this way through an angle of about 60 deg. After a further five minutes at 695 deg. C., the piece was taken out and rapidly quenched. At the bend, pearlite was always present, but in the limbs, where the metal had been distorted, the structure consisted almost entirely of ferrite and martensite.

A similar, but less pronounced effect, was produced when strips were bent at 700 deg. C.; pearlite was present only at the bends, about one-fourth of the austenite having crystallised. The first results obtained by hammering only were therefore fully corroborated in these bend tests. They show that lag at Ar1 can be appreciably diminished through deformation.

It should be noted that although lag was reduced it was not completely eliminated by the methods of deformation used, for in a previous investigation with the same steel globular pearlite was found to grow between 705 and 708 deg. C., when carbide nuclei were present in the austenite. Possibly, if the metal could be sufficiently distorted, lag in the formation of lamellar pearlite would be equally diminished.

In conclusion, it may also be mentioned that since a certain amount of lag also occurs at the Ar3 point, a few similar experiments were made in order to ascertain whether this supercooling could likewise be reduced by deformation. Strips were heated to 900 deg. C., cooled to temperatures a little below Ar3, and then bent. Here, however, the separation of free ferrite from the solid solution did not appear to be accelerated by the deformation produced in this way.

* A Paper read before the York meeting of the Iron and Steel Institute.

WE ARE SORRY TO ANNOUNCE that Mr. Matt Riddell, past president of the Institution of British Foundrymen, is at present quite unable to attend to business through ill-health. We trust that he will soon be restored to health.

LONDON FOUNDRYMEN will be pleased to learn that the Sir John Cass Technical Institute is organising foundry classes on a more important scale during the coming session. Mr. Wesley Lambert, president of the London Branch of the Institution of British Foundrymen, is giving a substantial prize, and Mr. J. Ellis, a past-president of the Institution, is to be examiner for this purpose.

HYDRO-ELECTRIC DEVELOPMENT IN INDIA.—Sir Ganga Ram, C.I.E., M.V.O., who is at present in this country, has placed an important order with Vickers, Limited, for water turbines and electrical plant, in connection with the development of power from a low head fall on the Bari Doab Canal in the Punjab. The head which will be utilised is only 6 ft., and the total power obtained will be 1,925 h.p. The energy will be transmitted to various pumping stations, where irrigation water will be raised, thereby enabling larger areas of good land to be cultivated. The extreme low head makes the proposition an exceedingly interesting one from a hydraulic point of view, and it is pleasing to note that British manufacturers are now in a position to carry out such projects.

Analysis Control in Acid Electric Steel Practice.*

By A. C. Jones, Chicago.

(Slightly Abridged.)

Too Many Changes in Practice Costly.

In making steel many foundrymen change the melting practice too often. When trouble occurs with the castings, which may or may not be due to the metal, a change is thought necessary which possibly means a more expensive practice. Then when everything goes smoothly as far as the quality of metal and even operation are concerned, an effort is made to cut down on the expense in some way. This brings further changes which sometimes are converted into more trouble. A change in practice should not be made once this phase has been carefully and thoughtfully adopted unless there is a strong reason for it.

Sometimes there is a tendency to start out with a fine programme and to gradually change it little by little. After fairly good results have been obtained for a long period a review of the original schedule will show that many little points which affect the analysis and cost of the steel have been neglected. Although it is necessary for the melter to depart from a possible schedule of additions sometimes, if the conditions are made as uniform as possible there should not be need for it often.

Charging Considerations.

The first heat from a cold furnace often is more difficult to bring to the desired analysis than the following ones. If the interval between this and the former heat is not over three hours, charging the furnace directly after pouring the last heat would not affect the working of it. If the interval is greater, charging immediately before the power goes on is better, unless the atmosphere of the furnace can be made non-oxidising immediately and furnace sealed tightly. This is difficult to accomplish. Charging in advance causes considerable oxidation, particularly with material such as turnings, flashings and material having great surface area. The result is that by the time the power goes on there is a heavy scale on all parts of the charge. This gives a thin slag, the bath melting down low in silicon, manganese and carbon. This also is severe on the roof and lining, particularly with furnaces of heavy power-input where the violence of the arc causes considerable splashing of this thin slag against those parts of the furnace. This may be compensated by charging some of the heavier material first and adding the turnings just before starting the heat.

Once the power is on, it should not be taken off unless absolutely necessary until the charge is in a molten condition. If there is any work to be done such as changing electrodes, it should be taken care of before starting unless only a minute or two will be used. When parts of the charge are heated to a temperature ranging from 815 deg. Cent. to the melting point, excessive oxidation or scaling takes place and the slag becomes rich in iron oxide. This condition is still more aggravating where the furnace is not kept air-tight during the melt down.

All will admit the furnace should be kept well sealed. This means not only a saving in time and energy, but helps to give a uniform blanket of slag on the melt down of each heat, all other conditions being the same. This is more important on furnaces that melt slowly and where the volume of oxygen passing into the furnace is much greater because of the longer melting time. Not only is there a benefit in time, energy and control, but there is an economy in electrode consumption due to oxidation of the electrodes.

Another factor in analysis control is the silicon, carbon and manganese content of the charge going into the furnace. It would be folly to state here the requirements for all furnaces. This has to be worked out at each plant. The writer has aimed to get sufficient silicon, manganese and carbon in the charge so that when the heat is melted and fairly hot and the finishing of the heat is to start, the silicon will be about 0.97, manganese 0.09, and carbon about 0.013 per cent. If the nature of the charge has to be changed, and the silicon and carbon come higher on the charge average, a certain calculated amount of ore must be added. Melting down to the above analysis gives a suitable thin slag that is not so oxidising as to leave the bath highly saturated with oxide. It is desirable to get the residual as low as stated, because at this point the steel clings tenaciously to these elements. Therefore, if the proper mixture is used all of the heats will come close to the above analysis from which the increases can be made with regularity. If on the other hand a mixture higher in metalloid content is used, some heats on account of greater oxidation will get to this level while other heats being less oxidised will have a much higher residual content and the final analysis will show high results. In other words, the idea is to melt down to a similar condition as is obtained in converter practice and then to build up quickly to the desired analysis.

The writer has found that with the Moore-type electric furnace melting a 3½ ton heat in one hour and 20 minutes, the mixture analysis to give the above residual content is about 0.22 silicon, 0.63 manganese, and 0.30 carbon, using 50 per cent. shop scrap and about 30 per cent. turnings, the remainder being forgings and shearings. The manganese is not considered important as it depends much on the actions of its partners, silicon and carbon. If they are high the manganese will stay also.

Causes of Low Silicon.

A lower silicon than desired is due to an excessive amount of iron-oxide in melting down. An excess of iron-oxide may be due to too much oxygen over a short or long period entering into the melting chamber and attacking the steel during that time. This is aggravated if there is not sufficient silicon, manganese, and carbon in the charge to neutralise some of this oxidising power. Scrap with excessive rust and having a large surface area exposed to whatever oxygen may be about will cause an increase in oron oxide. A low silicon and carbon content of the charge will cause a more oxidised bath and slag, all other conditions being the same.

To prevent such a condition, the furnace should be kept as air-tight as possible even after all is melted. The condition of the charge should be kept as uniform as possible, both as to analysis and physical condition. If there is more rust and some of the material is lighter, the silicon content of the charge should be increased slightly. In the first heat out of a cold furnace a longer time usually is required for melting. This heat should have a higher silicon and carbon content than the others.

If after an attempt has been made to prevent it, a thin oxidising slag persists, the best thing to do is to slag off some of it so that less than the usual amount remains on the surface of the bath. Then add three or four shovels of sand, preferably silica sand, spreading it well so that it will be incorporated evenly and quickly into the slag. More may be necessary, but observation of the slag will show this, it becoming a little viscous when sufficient has been added and the steel is fairly hot. After the slag has been prepared in this manner, the bath should be rabbled to bring the steel in the lower part of the bath in contact with the slag. This helps particularly in quick melting where often the surface steel is properly deoxidised while the bottom is full of oxide. Silicon pig is then added to raise the charge to the normal silicon content on the melt-down. The increase is perhaps 8 to 10 points, allowing a little for loss.

The silica analysis of a proper finishing slag should be between 50 and 60 per cent. With a higher silica content the slag becomes a little too thick for good roof and lining life. A thin, watery, oxidising slag will vary between 15 and 30 per cent. silicon content.

* A Paper read before the American Foundrymen's Association.

Causes of High Silicon.

High silicon is usually due to either a higher melt-down than usual where the oxidation of the elements silicon, manganese and carbon was much less than normal, or to an excessive reduction of silicon in the slag with the aid of carbon.

The first condition will be noticed as temperature tests are taken; the metal will lay very quiet. Adding a shovel or two of ore as soon as possible will help. A reduction in amount of silicon to be added also is advisable. The amount to cut down, of course, depends on the melter's observation.

Reduction of silicon from silica has been a bugbear in the operation of many electric furnaces. Where the carbon content of the steel is above 0.25 per cent., considerable reduction takes place as the temperature goes up. A charge high in carbon melting down to 0.25 so that little carbon has to be added will pick up a good bit of silicon if the slag is right. With the high temperature obtained under the three electrodes, the reduction is greatest in these regions.

However, if the bath is kept at the carbon content of the proposed melt-down analysis of 0.15 per cent., practically no reduction takes place. Then if the carbon is added at, say, 2 to 3 minutes before the power is finally taken off and this time that the power is on after the carbon addition is kept the same, one heat after another, the silicons will show a surprisingly small variation, where other conditions are constant.

At the plant with which the writer is identified, the present practice in adding carbon for a regular heat of 0.25 carbon is to dip two of the electrodes into the steel just before adding the manganese. The power is on only for exactly two minutes, checked by a stop watch. The pick-up of silicon cannot vary much when this is done. The danger of high silicon from heats calculated to finish with carbon much higher than 0.25 is negligible, as the increase is obtained by dipping the electrodes at the end of the melt, after the power is off, to obtain the extra carbon.

To give a satisfactory deoxidised slag and keep the silicon, carbon and manganese stationary to the end of the heat, we have been using lately about 25 lb. of pea-size anthracite to a 3-ton heat. This is being added about 20 mins. before the heat is finished and is spread over the slag as uniformly as possible. Chestnut-size coal was tried, but it seemed that some of the heavier pieces penetrated the steel to a certain extent, raising the carbon indefinitely. Using the pea-size has eliminated this irregularity. There is a little pick-up of silicon by the bath, but this will be the same on all heats if it is introduced at the right time. This amounts to about 5 points.

A greater loss of silicon, manganese and arbon in melting down is experienced with a furnace melting slow and using graphite electrodes, than the same furnace with greater transformer capacity and using carbon electrodes. The oxygen in the chamber is readily changed to carbon dioxide by the carbon electrodes leaving a more neutral atmosphere and, therefore, allowing less oxidation. However, graphite is not so easily attacked as the loss in pounds of electrode per ton indicates. Such opposite conditions may explain the varying amounts of silicon, manganese and carbon additions used in electric furnaces of different plants.

Solving Problems of Carbon Control.

The steel seldom picks up carbon in the same sense that silicon is said to be gained. High carbon sometimes comes unexpectedly because of malfunctioning of the automatic control at the end of the heat. If an electrode breaks off and becomes partly submerged, the carbon rises rapidly. Watching the board is the best precaution possible. The hazard of high carbon is greater with the use of amorphous carbon electrodes than with graphite ones. The rate of absorption by the steel from a broken electrode is much more with carbon than with graphite.

To bring down the carbon in such cases, unless it is hopelessly high, it is advisable to keep the power on and add sand to the slag to make it more silicious. The carbon then reduces the silica of the slag and the bath therefore loses its carbon. It usually is, advisable to rabble the bath well after the electrode has been fetched out and a sample should be analysed immediately for carbon. To facilitate the lowering of the carbon the bath should be rabbled a couple of times so as to bring the high carbon in contact with the silicious slag. The above procedure may mean a little higher silicon than usual, and a hotter metal than would be desired. But it is believed that this is more satisfactory than the attending conditions when the bath is ored down, causing a greater slag burden and more unpleasant operation as well as greater wear on the furnace.

Some melters have considerable trouble in keeping their carbon up. On some heats they seem to lose more than on others. The ideal condition would be to incorporate the carbon as near as possible to the end of the heat. But when adding pig-iron, the power must be on a sufficient time to incorporate thoroughly the amount necessary, which on a 6,000-lb. heat with a residual carbon of 0.12 to 0.15 per cent., would mean 175 lb., not allowing any for loss. (Theoretically this would require about 2.9 per cent. of the time of melting the heat or about 3 minutes.) Then, again, the power would be on after the manganese had been added to the bath. Therefore, during this period there is a chance for quite a variation in loss, one heat from another. Dipping the electrodes in the bath has proved satisfactory. We have adopted the following practice after determining the rate of carbon absorption by the bath from the electrodes. This was found practicable only with graphite electrodes, the rate of absorption being much more uniform than when using amorphous carbon electrodes. When the heat has reached the desired temperature, the power is turned off and two electrodes are immersed to a depth of 7 in. for 75 sec. (total elapsed time). With our regulation it takes 15 sec. for the electrodes to get down 7 in. and allowing 15 sec. for the return they remain stationary in the bath 45 sec. This is slightly varied as indications warrant. Immediately the bath is rabbled well from both the spout and the door to mix thoroughly the metal. The power is then started, and after 15 sec. the manganese is added. At the end of 2 min. the power is taken off. The bath is again rabbled well and heat is ready to pour. Should higher carbon steel be needed, the electrodes are again immersed at the end for as long as is necessary. It is advisable to use three electrodes rather than hold any one over 100 sec. The rate of absorption changes as the carbon is removed from the electrode.

To realise the full benefits of the above method, a fracture test should be examined just before adding the carbon to the steel. This may cause a decision to vary the length of time the electrodes are in the steel.

Problems of Manganese Control.

Manganese control should be easy if the carbon and silicon are uniform. The following are pertinent points in manganese control:—(1) Lower carbon than usual means slightly lower residual manganese. (2) Lower silicon than usual results in lower residual manganese. (3) When small lumps of ferro-manganese are prevented from reaching the bath by a viscous slag, lower manganese will result. (4) Variation of the time that power is on after adding the ferro-manganese will give a corresponding variation in manganese content. (5) The volume and nature of the slag affects the control.

The first and second causes should be apparent to the melter by the time manganese is to be added, and therefore he can increase his additions slightly. The third cause is preventable, as sacks or containers can be obtained for pieces that might be trapped in the slag. Such containers serve their purpose well. The fourth factor, time, must be watched with consistent accuracy—even to seconds. Two minutes is ample time. Any longer period means the enriching of the blanket of slag with good manganese from the steel. This brings us to the fifth point. Too much slag means more manganese to satisfy the greater capacity for absorption. For this reason slagging off is desirable earlier in the heat where an extra heavy amount of slag is noticed.

The temperature of the steel has a slight bearing on the control of all three elements. Exceed-

ingly hot steel loses carbon and manganese, the manganese going into the slag and also volatilising slightly.

Closer control of manganese can be obtained when adding all of the ferro-manganese in the ladle, in small lumps, but the advisability of doing this is a matter on which there is a considerable difference of opinion.

Aspects of Control Problem.

The sample of analysis is an important factor. It should be taken from a bar that will chill quickly in the sand, say 2 × 3 × 1 in. The usual precautions for drilling samples should be kept in mind.

The test bar should be poured at the same time on each heat, preferably at the half-way mark. Tests made on samples after regular time intervals on the same heat have shown a consistent change in analysis. This was most pronounced with the element manganese, particularly when the heats were hot, the decrease being as much as 8 points from the first to the last metal on some unusually hot heats.

Mr. McLain's European Visit.

The many friends which Mr. David McLain has made in Great Britain will be pleased to learn that his physician considers that his eye has made sufficiently rapid progress to enable him to visit France. He left last Tuesday for Paris, and will be taken care of by Mr. Zeeman, European Representative of the Osborne Moulding Machine Company, and Mons. Ronceray, of Choisy le Roi. On his return he hopes to be able to visit some of the more important foundry centres.

Electric Furnace Melting Costs.

Mr. C. W. Francis, who has been writing a series of articles on the subject of electric furnaces in the *Iron Age*, gives in the issue of August 31 a most interesting comparison between the costs of making ordinary mild steel by the acid and basic electric processes. His table shows that the acid steel is 3.5 dollars per ton cheaper than basic. This is solely due to the time factor, the acid furnace being capable of being run so much more quickly than basic.

We understand that only one firm in England is making acid electric steel castings, and this works satisfactorily with a conducting hearth. There seems to be a considerable field for the acid plant in Great Britain, as considerable quantities of low sulphur and phosphorous scrap is available.

Roumania Wants Crucible Tool Steel.

The Commercial Secretary at Bucarest reports that the Roumanian Railway Administration are inviting tenders for the supply of 120 metric tons of crucible tool steel. Tenders, which should be addressed "La Direction Generale des Chemins de fer Roumains," Service P. (Calea Victoriei No. 124), Bucarest, will be received up to 11 a.m. on September 22.

Quotations are required covering delivery c.i.f. Roumanian port, and it is understood that payment will be effected in thirty to forty days after arrival of the goods in the railroad stores. The successful tenderer will be required to pay a registration tax of 1 per cent., and also to make a deposit of 10 per cent. of the value of the contract.

Representation by an agent resident in Roumania is considered to be essential, and the Department of Overseas Trade is prepared to suggest to United Kingdom firms interested in the matter the names of suitable agents to act for them.

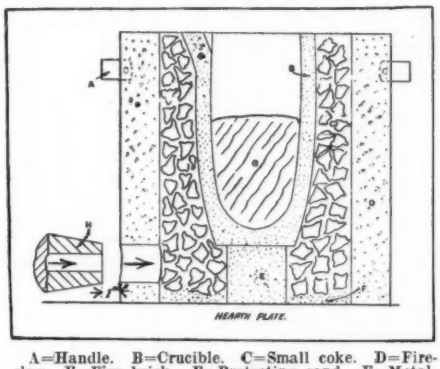
One copy only of the specification, conditions of contract, and tender form (in French) have been received and can be seen by United Kingdom firms interested, on application to the Department of Overseas Trade, Room 49, 35, Old Queen Street, S.W. 1 (Ref. 9,000/F.E./E.P.).

An Emergency Melting-Plant.

By F. A.

While on compulsory holiday in an out-of-the-way district the writer's services were requested in connection with a breakdown at a local garage. The subject was a motor-cycle, apparently scrap, unless a certain type of 3-speed gear box could be fitted. It was doubtful, even with the special fitting for securing the gear box (which would mean taking the frame to pieces and rebrazing with the fitting in position), whether the belt pulley and sprocket wheel could be got in correct alignment, and two garages had previously refused the job as hopeless. It appeared to the writer and the owner of the garage, however, that by removal of a portion of the gear-box (without affecting the vital parts) and the substitution of a special casting and clip, the trouble could be overcome and the gear-box fitted without alteration to the frame, if the castings could only be obtained. As the nearest foundry likely to be able to supply them was over 50 miles distant this looked like being a long job, even if a pattern could be quickly supplied.

Other castings being occasionally required, in aluminium and bronze, a small crucible was ordered, to hold about 36 lbs. of bronze or about 12 lbs. of aluminium, with the intention of using a small portable forge for melting purposes. By the time the crucible arrived an old oil drum, about 14 in. dia., had been cut down to about a



A=Handle. B=Crucible. C=Small coke. D=Fireclay. E=Fire brick. F=Protecting sand. E=Metal. H=Blast nozzle.

foot, and a circular piece 10 in. dia. cut out of the base, a 2-in. hole being also cut out of the side about 2 in. from the base. A short log, about 10 in. dia., was used for a plug, while the interspace between it and the drum was rammed with fireclay. The 2-in. hole, which was intended for a tuyere or blast inlet, was carried through the fireclay and the plug removed. Whilst the fireclay was being carefully dried, a wooden, two-part moulding-box was made, and means of location provided. A crude pattern was prepared for the required casting, and whilst the aluminium was being melted in the fireclay-lined casing, set on the hearth of the portable forge, with the 2-in. hole opposite the nozzle, and coke as fuel, the mould was prepared, and within an hour was cast. Since then other emergency jobs have been cast, both in aluminium and bronze. Starting with a good fire, 10 lbs. of fluid bronze was obtained in half an hour, whilst a pot full of aluminium can be melted in 45 min.

Such a furnace would be quite suitable for emergency jobs, even in cast iron, with a little more fire space and greater depth, but naturally would be better if the blast was supplied from a small power-driven fan instead of the hand-operated lever bellows.

The illustration (Fig. 1) outlines the arrangement, which was provided with suitable handles for removal when finished with. The sand for the moulds was obtained locally.

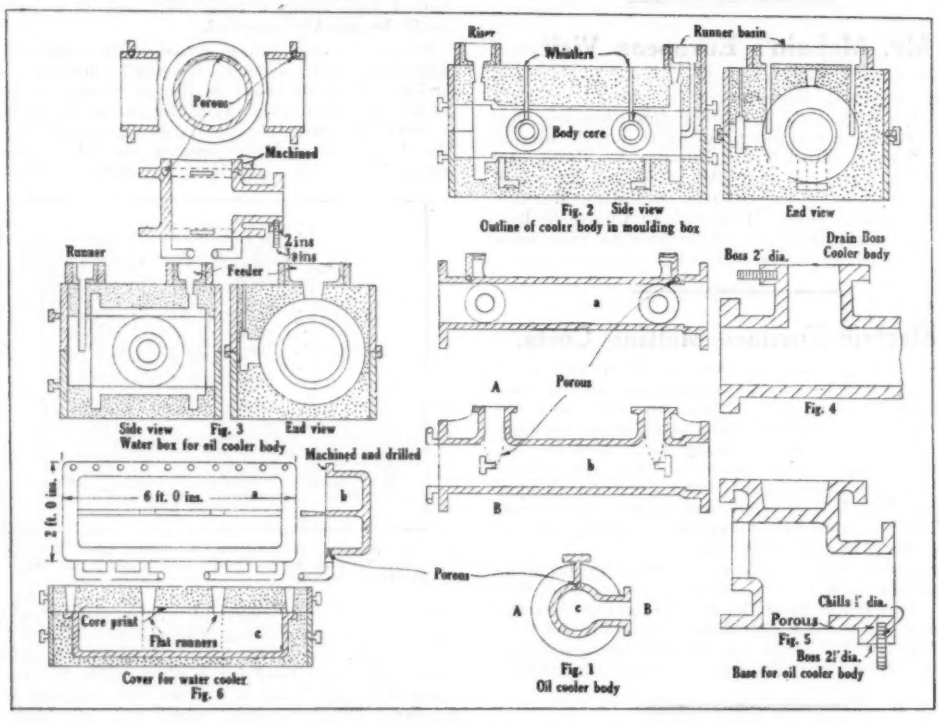
THE STAR FOUNDRY COMPANY, LIMITED, of Batman's Hill Road, Cosely, Bilston, have just constructed a new foundry for non-ferrous castings.

Pressure Trouble with Oil Cooler Castings.

By S. G. Smith.

The castings discussed in this article are for oil cooling and consist of bases, bodies and water boxes, being bolted together to form an important part of the oil cooling arrangement.

The castings are all pressure-tested separately, and must be perfectly sound before being assembled. The cooler bodies vary in dimensions both in diameter and length according to the quantity of heated oil to be cooled. The diameter of bore would be approximately from 6 to 12 in., and the length from 4 to 6 ft. The dimensions of the bases and water boxes would correspond to the cooler bodies. Regardless of size, the defects were very similar. Fig. 1 shows a cooler body, which, as a rule, are bored out to a definite size, in order that the perforated discs should have a true inner surface. These round discs, several of which are used in each cooler body, hold together the numerous brass pipes, through which the cold water passes to cool the oil. Thus the discs and the brass pipes must be true fitting.



Porous Plates.

In Fig. 1 three through sectional views, *a*, *b* and *c*, are given in order that the position of the porous places may be clearly understood. These are indicated by arrows.

When the writer took this trouble in hand the castings were poured as shown in view *a*, *id est.*, the brackets were uppermost, which was the basic cause of the porous places. At the dotted lines in view *b*, Fig. 1, where trouble was also experienced, spread on the branch cores, which were carried a quarter way round the circumference of the body, was, by consent of the engineer, reduced to a plain diameter spread, as shown in views *b* and *c* (Fig. 1).

The brackets near to arrows were altered to mould the opposite way, as shown in Fig. 2, which includes a side and end view of the outline of the casting in the moulding box as poured.

Reversing the method of pouring, reducing the spread on the branch cores, and running the casting from the opposite end to the gland end, each contributed to eliminate the porous and faulty places. In addition, these castings must always have the best conditions, such as a clean mould, good cores, and good hot iron.

If at any time it is considered with the larger-sized cooler-bodies to pour vertically, all precautions consistent with vertical moulding and pouring must be taken, otherwise more trouble will follow than when poured on the horizontal.

Water Box.

Fig. 3 shows a water box, and is attached to the gland end of the cooler body. The chief faults associated with the castings are porosity in the two places indicated by the arrows, and have reference to the spigot-end (where shown machined) and the boss for the drain cock which adjoins the branch flange. The castings were moulded and poured as shown in the side and end view of the moulding boxes, and were rammed on a jolting machine.

To overcome porosity at the spigot end, an enlarged feeder was fixed on the pattern as shown in the centre sketch of Fig. 3, the side and end view of the moulding showing this more clearly. Care had to be taken that the swell on the side of the flange which remained on did not interfere or foul the drilled bolt holes. Of course, this enlarged feeder required to be rod-fed as long as possible, otherwise the porosity would almost have been as great as before. The porosity continued for a third of the diameter as shown. Many castings did not reach the water test, but were scrapped during machining, the porosity showing up during operation. The drawn place which existed in the boss for the drain cock shown in the centre sketch was overcome by a very simple remedy, which will be referred to in the next two Figs. 4 and 5. Both methods adopted were quite satisfactory.

Cooler Body.

Fig. 4 is an end section of a cooler body, and Fig. 5 is a cross section of the base, which is bolted to the end of the cooler body. Each of these castings has a drain-hole boss. As only a ¼-in. or ⅜-in. dia. gas tap passes through the boss, it is cast solid, drilled and threaded according to requirements. Almost without exception every casting, whether it be cooler body, water box, or base, has shown porosity at this boss.

The chills do not pass right through to the core, this being arranged so that the mean thickness of the section can be allowed between the end of the chill and the body core. The diameter of the drain bosses and the diameter of the chills are different, in order to accommodate in the latter

the size of the boss, the size of the tapped drain hole being previously ascertained. For instance, a 2½-in. dia. boss would have a ⅜-in. gas tap, the diameter of the chill was decided upon as ½-in. The 2-in. dia. boss would have a ½-in. gas tap, and the diameter of the chill would be ⅝-in. These small chills, or denseners, were most effective. The boss, when drilled and threaded, was perfectly sound and water-tight. The chill is self-centreing in the mould, a print being added to the pattern. The length of the print decides that the longest half of the chill will be in the print; this also determines the length of chill that extends into the casting. When the mould is closed, the print will hold the chill firmly in position. This is essential, as there is only a small margin allowed around the chill, as is shown in Figs. 4 and 5.

Cover for Cooler Body.

Fig. 6 shows a cover for a water-cooler. The trouble with these castings is usually due to the position of the runner-ingates indicated by dotted arrows on sketches *a* and *b*. The spray runners were cut along one side of the cover as shown; consequently, when the castings were machined and drilled on the runner side of the cover, the flange was full of porous places indicated by arrow on sketch *b*. This was so bad that a wire could be passed from one drilled hole to the next. Hence some castings were rejected before reaching the water pressure test, whilst others were rejected due to failure at the test. The opposite and end flanges were perfectly sound. The drawn places were found in the hottest parts, which remain therefore longest in the liquid, or semi-liquid condition occasioned by the last or hottest metal from the ladle remaining opposite the ingates in the drawn flange. This occurrence is by no means uncommon.

The remedy for such drawn places is a better and a wider distribution of the molten metal through the runners, and in this case the position of the runner gates was moved from the flange to the centre dividing rib, as shown, passing through sketches *a*, *b* and *c*. Sketch *c* also shows the cover on the moulding box.

If no rib existed in the design of this casting the best method of gateing would be through the centre of the core, as shown at continued dotted lines of the flat runner.

Austrian Iron and Steel Industry.

Present Conditions.

According to a recent article in "Commercial Reports," there are now in operation in Austria 3 coke blast furnaces of a capacity of 400 tons of pig-iron per day each, and 2 small charcoal furnaces of 13 tons per day each. This is about 50 per cent. of the total capacity of the 11 blast furnaces in the country. The production of pig-iron for the first quarter of 1922 was about 22,000 tons per month; the actual amount increased from about 20,000 tons in January to 24,000 tons in March.

Of the 74 steel furnaces in the country, 30 furnaces (17 open-hearth, 4 crucible, and 9 electric) are in operation, giving an average monthly output for the last quarter of 1921 of 28,600 tons, of which only 1 per cent. was crucible ingot steel. The total steel production capacity of Austria is about 60,000 tons per month. There are some 25 iron and steel rolling mills, producing at present (April, 1922) about 40 per cent. of their capacity. This production is increasing, but is dependent upon the supply of raw material obtained locally and by importation from Germany and Czecho-Slovakia. Practically all rolled products are made, especially bars, sheets and plates, rails and other railway material, structural work and wire.

The production of pig-iron is almost wholly by the Alpine Montangesellschaft which has all of the blast furnaces operated with coke and one of those operated with charcoal, besides large steel works and rolling mills. It has an abundant supply of high-grade iron ore but must import all of its coke and most of its charcoal. Until a year ago it was entirely dependent upon Czecho-Slovakia for coke, which was limited in quantity and burdened with the condition that half of the pig-iron produced should be exported to Czecho-Slovakia. When the Stinnes group acquired control of the Company, coke was secured from the Ruhr district in Germany, and the production was much increased.

The Ruhr coke at the end of March cost about 65,000 Austrian crowns per ton, but the supply was uncertain, the Allies making difficulties and requiring the purchase of English coal, paid for in English money, in substitution. Czecho-Slovak coke was at the same time plentiful, but cost 110,000 crowns per ton delivered at the furnace.

The Alpine Montan Company is planning to increase its capital and to enlarge its capacity for pig-iron production by 40 per cent., and for steel production by 20 per cent. The details have not been given out officially, but it is reported that the Company is indebted to the Vienna banks to an amount exceeding 8,000,000,000 crowns and that in order to reduce this indebtedness and enlarge its works and build workmen's houses it intends to raise its capital from 100,000,000 crowns to a nominal 600,000,000 crowns, issuing the new shares at a price equal to one hundred and fifty times their nominal value. (The exchange rate at the end of August was 300,000 to 350,000 Austrian crowns to the £.)

In the second half of 1921 the Austrian imports of iron and steel were 30,962 tons, the chief items being foundry pig-iron (24,653 tons) and scrap (3,720 tons). Of this 58 per cent. came from Germany and 39 per cent. from Czecho-Slovakia. There were imported 7,052 tons of semi-finished iron and steel, of which 70 per cent. came from Germany and 3.2 per cent. from Czecho-Slovakia, the chief item being 4,769 tons of puddled bars. Germany supplied 65 per cent. and Czecho-Slovakia 33 per cent. of the 56,647 tons of finished iron and steel imported. Prominent among these imports were 18,873 tons of bars, 11,459 tons of sheets and plates, and 2,924 tons of wire.

Germany and Czecho-Slovakia have a monopoly of the Austrian market at present.

Austrian exports of unfinished iron and steel in the second half of 1921 amounted to 31,175 tons, the chief items being pig-iron, 11,572 tons, and scrap, 2,400 tons. Germany took 6 per cent. of these exports, Czecho-Slovakia 66 per cent., Hungary 3 per cent., Yugo-Slavia 5.8 per cent., and Italy 12 per cent. In the same period 4,478 tons of semi-finished iron and steel were exported, 52 per cent. of which went to Yugo-Slavia, 17 per cent. to Germany, 3.6 per cent. to Poland, 1 per cent. to Hungary, and 0.5 per cent. to Czecho-Slovakia. Finished iron and steel was sent abroad to the amount of 71,408 tons, the most important items being bars 18,131 tons, plates 8,938 tons, wire 7,791 tons, and hardware 36,551 tons. Yugo-Slavia bought 37 per cent. of these products, Germany 14.3 per cent., Poland 11 per cent., Czecho-Slovakia 7.8 per cent., and Italy 7.6 per cent.

MR. S. BOOTHROYD, of 23, Edmund Street, Bradford, has been appointed agent in the North of England for the Burton Foundry Company, Anglesey Road, Burton-on-Trent.

MR. J. LONGDEN, who has been acting as assistant secretary to the London Branch of the Institution of British Foundrymen, has been appointed foundry superintendent to D. & J. Tullis, Limited, Kilbowie Ironworks, Clydebank, Glasgow.

Tata Iron and Steel Company.—A cable from Bombay states that the report of the Tata Iron and Steel Company for the year ending March 31, 1922, shows a profit of 88¼ lakhs (£588,333). No dividend is to be paid on the ordinary shares. The report refers to the past year as one of the worst the iron and steel trade ever experienced, with prices constantly falling and the cost of production increasing, but considers that the Company's results may be regarded as successful when compared with those of similar concerns in other countries.

Malleable Iron or Semi-Steel Scrap?—Mr. Commissioner Finlay had to decide this question at the Warwickshire Summer Assizes. An action was brought by Messrs. Cox & Danks, iron and steel merchants, of 168, Regent Street, London, to recover £421 for scrap supplied to the Reliance Foundry Company, Willenhall. The defendants alleged that some scrap material sold was steel or semi-steel and not malleable iron scrap, but Mr. Commissioner Finlay decided that there was no misdescription, and gave a verdict for the plaintiffs.

Position in the Australian Iron and Steel Industry.

The Australian mail recently to hand contains a report of an explanatory statement issued by the Broken Hill Proprietary Company, Limited, in regard to the present position of the iron and steel industry in Australia, with special reference to the Newcastle (N.S.W.) Works.

At the outset they mention that twelve months ago between 5,500 and 6,000 men and officers were employed at the steelworks at Newcastle. At the time of the report (June 22, 1922) only 840 had employment. After careful examination of the situation as it appears to-day, the directors have come to the conclusion that there are three main things necessary to be overcome to enable the Company to quote sufficiently low prices to meet overseas competition and thus enable them to receive orders and restart the steelworks. The three main factors are:—(1) Price of coal; (2) the matter of hours; (3) wages.

Coal.—The directors think that they will be justified in restarting the works if best or large coal is reduced by 4s. per ton, and small coal by 6s. per ton. Since the iron and steel industry has been started at Newcastle, the price of large coal has been increased from 11s. to 21s. 9d., approximately 100 per cent., but small coal has been increased from about 7s. to 17s. 9d. per ton, equal to 153 per cent. increase. As three tons of coal are required, approximately, to produce a ton of steel, the enormous increase in the cost of manufacturing steel is shown.

Hours.—In the matter of hours, the Company have been placed under a great disability by the institution of the 44-hours' week, and it is necessary for 48 hours to be reverted to before operations can be commenced.

Wages.—The latest basic wage in New South Wales is £3 18s. per week, and the Company are unable to start under this finding; they could, however, start at a minimum wage of £3 10s. per week. In the iron and steel industry in England ordinary unskilled labour received a weekly wage of 47s., and in the United States 60s. per week.

In addition to these conditions, several adjustments of a minor nature with the New South Wales Government are essential.

The Company are hoping to further assist the position by salary reductions, better general efficiency, improved methods, and lower freights. The Company's policy is to have some of their technical officers always travelling abroad in order to keep the works in line with the most modern practice.

The cost of coke at the Newcastle steelworks manufactured in up-to-date ovens in 1921 was 37s. 4d. per ton. English coals are very much lower in ash than those used for making coke in Australia. In addition, English coal mines produce coal of various grades, and it is the fines or "duff" of these coals which is used for making coke in England and America; whereas in Australia there are only two classes of coal produced—viz., best and small. In Newcastle it is the small coal which is used for making coke, but unfortunately there are insufficient quantities of smalls in Australia with coal mines on low output. It is therefore necessary to use a certain amount of large coal also. The f.o.b. price of small coal in Newcastle in June was 17s. 9d. per ton, but owing to the insufficient quantity of small coal the cost of coal for coke-making purposes was 19s. 3d. per ton.

Statements have appeared in the Press misleading the public regarding the amount of capital invested by shareholders in the steelworks at Newcastle. It is thought that the fairest way to explain this position is to quote from the report of an independent accountant, appointed by Judge Beeby, to inquire into the Company's books as to costs and capital invested. Mr. Watt (the accountant mentioned), in his report dated March 16, 1922, clearly shows that, at November 30, 1915, the various funds belonging to the shareholders were as follows:—

	£	s.	d.
Subscribed capital	472,402	8	0
Premiums paid by shareholders in 1918 on issue of shares ...	353,609	12	0
Up to May 31, 1921, there was a further issue of shares which increased the capital by ...	480,534	12	0
And, in addition, premiums paid by shareholders on these shares	954,206	13	0
Making a grand total of money subscribed in cash by the shareholders of	2,260,753	5	0

Further, £2,500,000 was raised by debentures subscribed by the public, and was also expended in establishing the Newcastle industry. Thus the total amount of money subscribed by share and debenture holders for the establishment of the steel industry at Newcastle amounts to £4,760,753 5s.

In addition to the above, from the sale of the lead smelters at Port Pirie, and from undivided profits derived from Broken Hill, a total of £1,800,000 was expended in establishing the industry at Newcastle, which amount was subsequently capitalised. Of this £1,800,000 an amount of £1,500,000 was issued from undistributed profits which had been allowed to accumulate whilst the Company's business was being developed.

Of the above amount, £1,178,000 had been accumulated prior to May 31, 1914, which was before the steelworks had commenced operations.

The following quotation is taken from Mr. Watt's report to Judge Beeby, viz.:—"I have to report that since 31st May, 1914 (the first period investigated by me), the undistributed profits belonging to shareholders had been represented in the balance-sheet by way of income-earning assets, and they have thus increased the shareholders' general funds invested in the business. I desire also to state that the issue of £1,500,000 worth of bonus shares has been made without writing up the value of any of the Company's assets, and without reconstructing in such a way as would create any such intangible assets as good will. The net effect of the recapitalisation scheme adopted in 1918 and 1919 was merely to have certain shareholders' funds (accumulated profits), which were invested in an extension of the Company's business, recognised as shareholders capital."

U.S. Steel Workers' Wages.—The Bethlehem Steel Corporation, the Midvale Steel and Tube Company, the Brierhill Steel Company, and the Republic Iron and Steel Company, following the lead of the United States Steel Corporation, announce their intention of making a similar increase in the wages of day labourers. Pig-iron was sold at Birmingham, Alabama, on August 23 for $25 a ton, being the highest price since the war.

Zinc Absorption by Blast-Furnace Linings.—Mr. P. O. Menke, in a paper before the Eastern States Blast-Furnace Association (U.S.A.), points out that zinc vapour in iron ore is absorbed by the lining up to as much as 50 per cent. It usually shows up as small yellow crystals. Sometimes it is found with carbon deposits in the disintegrated and laminated portions of the lining. Some of this zinc shows up in the metallic form. It usually is around the water-cooled part of the furnace, also in the part of the lining that is not water-cooled, but had a chance to cool down after banking or blow out. In scabs that adhere to the water-cooled portion of the furnace, it probably combines with the alumina, forming zinc spinel, which is practically irreducible, as these scabs are mostly still present and intact after the furnace has been blown ont. It is also generally assumed that the zinc oxide combines with the alumina in the fire brick. As the coefficient of linear expansion of zinc is like 60 to 1, compared to silica (which is the principal constituent in fire brick) and is about 3 to 1 compared to steel, it can readily be seen that it would not take a great deal of impregnation to destroy the bond of the brick and exert great expansive stresses. The hand-made brick, on account of its greater porosity, has a tendency to take up more of this element than the steam-pressed brick. Most of the blue billy agglomerates carry zinc. No matter how low the percentage of zinc is in the raw material, on account of its being accumulative, it will eventually show up and disintegrate the lining.

American *versus* British Cast Iron

Mr. G. K. Elliott has used "The Canadian Foundryman" as a means of expressing his views. Mr. Elliott is well-known to British foundrymen, having been the first American author of the Exchange Papers. His communication reads as follows:—

It is with the closest interest that I have read this spirited and wholly praiseworthy exchange Paper. As an international Paper it is admirable, because of the insight it gives Americans into important points of British grey-iron metallurgy, and because of its very attractive controversial possibilities. The Paper cannot help but redound to the great good of grey iron theory and practice in both Great Britain and the United States.

There are two kinds of iron castings—those made from appropriate iron especially formulated for the particular castings, and those made from common nondescript cast iron which, while broadly useful, is not generally a felicitous choice for particular requirements. We suspect that Mr. Cook is comparing, in parts of his Paper, British iron of the first class with American iron of the second. If our British friends have found some American machine-tool castings faulty, it is possible that they belonged to the last class; especially would this be true if these castings were made under stress of war conditions when some manufacturers found their own foundries too small, and were forced to let out a part of their castings with a lack of discrimination that often was unavoidable. In this country, as in England, it is possible that machinery builders who make their own castings have the iron under intelligent control producing castings equal in every way to the demands of the intended service. I am a persistent advocate of specialisation in foundry irons, and therefore hail this part of Mr. Cook's Paper with special satisfaction, because it adds emphasis to a point all too little realised in some engineering circles. There is far too much needless obloquy attached to cast iron simply because a few manufacturers, through either ignorance or carelessness, are habitually allowing questionable grades of iron to enter into important castings.

Growth of Cast Iron.

Mr. Cook mentions reported failures of cast-iron parts in America under exposure to superheated steam. This phenomenon of growth and warping under superheated steam has been referred to by American writers with more frequency and emphasis than are justified by the instances of its occurrence. A search of technical literature shows that the most of the references go back either directly or indirectly to three Papers read before the American Society of Mechanical Engineers over twelve years ago. The number of cases reported since then is very small. These mentioned are not to be denied, but my long experience in this line convinces me that when fittings intended to handle superheated steam are made from appropriate iron the danger of failure is remote, except possibly where most uncommonly high degrees of superheat are used. I have yet to see the first valve or fitting made of suitable iron that has failed under this service. It is certain that cast-iron parts made by American manufacturers specialising in this line and making their own castings are made of iron entirely capable of encountering successfully the feared but somewhat over-estimated superheat peril.

Mechanical Strength.

The average of over 36,000 lbs. per sq. in. tensile strength attained by Mr. Cook bespeaks the sterling foundryman, and suggests that his iron falls within the category of special irons; at least, it would be unfair to set it up against iron of the common variety. Quite interesting in this same connection would be a record of strengths of iron melted in the average English jobbing foundry. I myself have seen many hundreds of heats of iron run without the aid of steel additions, having an average tensile strength corresponding almost identically with that obtained by Mr. Cook; the iron, however, was formulated for a particular purpose, and should not be compared seriously with the product of the ordinary foundry catering to a not fastidious trade. Mr. Cook's tensile and "arbitration" strengths in Table I. are highly commendable, but should not reflect unfavourably upon American iron, because his bars were cast on the main castings, while the arbitration bars were cast separately. It is well known among foundrymen that test-bars can be located so favourably in relation to the main casting, when "cast on," as to give great advantage to the bars even to the extent of giving a grossly exaggerated indication of the true strength of the iron in the main casting.

The attempt to reconcile the strength of the 1¼-in. round American arbitration bar with that of British 1-in. square bars by use of the factor 0.74 is not to be commended, because no account seems to be taken of the quite different manner in which square and round section bars form crystals while cooling. Mr. Cook used this same device in his very able and keen discussion of my exchange Paper before the Institution of British Foundrymen last year, and it is again referred to, where he calls attention to the fact that his lowest "equivalent load"* (evidently obtained through the 0.74 factor) was higher than the transverse strength of electric furnace refined iron mentioned in my Paper. Mr. Cook seems to take it for granted that the strengths mentioned in my Paper were exceptional for American iron. This was far from being the case; they were not given as being the last word in cast-iron test-bar strengths, but rather as illustrations of the improvement wrought in irons of somewhat lowly origin by treatment in the basic-hearth electric furnace. The strengths were shown in pairs, so as to depict the same iron before and after treatment, and so doing fulfilled their only mission of showing that the process materially improved the original cupola metal. That the strengths were in any way exceptional was not claimed. Purposely did I avoid injecting the phenomenal into the Paper, which fact does not seem to have been understood by several British commentators.

In the case of carbon in cast iron, I am sure it will be found that more iron foundries in this country pay attention to it than Mr. Cook suspects. These naturally do not include the great rank and file of unspecialised foundries already mentioned, but only such as make the better grades of castings. In making fittings for superheated steam, for instance, certain foundries pay great attention to the amount, the size, and the distribution of the free carbon.

Sulphur Question.

The sulphur question is taken up in the Paper, and it is safe to assume that this is one question that never will be settled to the satisfaction of everybody, especially of persons who, through geography or economy, are somewhat inescapably tied fast to high sulphur. To a less extent this also is true of phosphorus, in considering which Mr. Cook makes the important observation that its distribution is of utmost importance, that segregated phosphide is more dangerous than the uniformly distributed. It is my belief that high phosphorus and high sulphur will become less dangerous only when foundrymen learn a way to produce without fail both phosphides and sulphides in a certain optimum degree of dispersion and of certain critical particle size. I do not believe that foundrymen have yet learned the way to do this, but discussions such as Mr. Cook's will aid greatly in throwing the desired light upon the subject. As matters now stand it seems that sulphur and phosphorus are safest when absent.

Dynamic Tests.

I am much pleased to see Mr. Cook refer to tests of a more dynamic nature than the usual tensile and transverse tests. It is to be hoped that a more general adoption of dynamic or shock tests is near at hand, for I believe these tests will greatly increase our knowledge of the differ-

* See issue of July 20, page 60, col. 1.

ences between irons now apparently the same, as far as the usual static tests go, and yet which do not show up the same in service. I have in mind two sets of valve body castings weighing about 600 lbs. each that were broken up under a foundry drop-weight. One set was made from iron having about 0.08 per cent. sulphur and an average of two drops of the weight was necessary to break each casting. The other set was made of the same iron, but refined in the electric furnace, with sulphur at about 0.035 per cent.; these castings required four or five drops each to be broken. By transverse test the second iron was about 35 per cent. stronger than the first, by the drop test it was over 100 per cent. stronger.

Hot and Cold Blast.

The theory advanced in the Paper and attributed to Mr. J. E. Fletcher, concerning the relative effects of hot and cold blast furnaces upon the structure and properties of grey iron, is, by way of contrast, strongly suggestive of the thought advanced by the late J. E. Johnson in his theory of oxygenated iron. Johnson's theory is that the cool running charcoal blast furnace causes a certain marked oxygenation of the iron, which condition in turn, he contended, effects a compactness of the graphite formation that is not to be found in the product of the hotter running coke blast furnaces. On the other hand, Mr. Cook bases his claims for superiority in the iron from the cool running furnace, upon a quite different assumption—that through lack of oxidising conditions a certain boundary-inter-cohesional strength is preserved in the metal. Therefore, we are confronted with two theories, both touching upon the question of oxygen, and both claiming excellent properties in iron made in cool blast furnaces. One, however, attributes the superiority to oxygen picked up under the named conditions, while the other declares the iron to be superior because the same given conditions are not favourable to the taking up and retention of oxygen. Both theories touch upon fundamentals of the greatest interest, but neither is convincing, and we feel justified in demanding more and better evidence.

Molybdenum Steel Rolls.

In a recent issue of the *Blast Furnace and Steel Plant*, reference is made to the use of molybdenum steel rolls in rolling mills. These rolls are now being employed for the strongest roughing roll to the hardest finished roll. They are stated to be exceptionally tough, and will withstand long wear and tear.

Molybdenum rolls are estimated to give 200 per cent. increased service over carbon-steel rolls. It is believed that the use of these rolls will allow of a great increase in size of the entering billet, perhaps by as much as 30 per cent.

It is claimed that the introduction of molybdenum steel for rolls represents the greatest advance in the rolling mill practice that has taken place during the last 25 years.

Sulphur in Cast Iron.

Mr. G. K. Elliott, in a Paper read before the American Electrochemical Society, entitled "The Cast Iron as Produced in the Electric Furnace and Some of its Properties," states that it seems that the sulphur question is involved in the greater one of general refinement, and it is probable that iron high in sulphur also is endowed plenteously with other impurities, some of which may be almost entirely unknown. Examples are oxygen in various combinations, nitrogen as nitride, and perhaps others even less familiar. The fact that an iron is desulphurised is evidence that it has passed through a strong refining treatment, and the possibility that some of the benefits attributed to low sulphur in reality may be the result of the removal of one or more other impurities along with it, has to be recognised. Desulphurisation of iron means one of the most drastic cleansings known to metallurgy and consequently low sulphur is becoming a hall-mark of refinement.

Foundry Trade Technical Society.

New Organisation in Sheffield.

A progressive step was taken on Sept. 7 by the representatives of the foundry industry of Sheffield and district. At a meeting in the Applied Science Department of the Sheffield University it was decided to form a trade technical society similar to those established in the interests of the cutlery trade, the silver trade, the file trade, the edge-tool trade, the rolling mill and forge workers.

The need of such a society for the foundry trade, including iron, steel and brass trades, was clearly put by Professor W. Ripper, who presided over the inaugural gathering. He said the trade technical societies had been of considerable help to the trades with which they were associated, for they provided a means by which persons engaged in the respective industries could meet on neutral ground and discuss frankly their difficulties with the object of finding ways to overcome them. All the leading industries of the country, said Dr. Ripper, were assisted by scientific societies which were concentrating on their various problems and doing valuable research and pioneer work. But this was not all that was required. They must also be provided with opportunities to enable the workers to take some share in promoting these developments, and to enable that great body of men, who were neither students of technical schools, nor members of scientific societies, to take a useful share in considering existing methods and the ways and means of improving them. He was satisfied that the Technical Trade Societies provided such facilities. There were great possibilities in this movement, and the workmen had already shown unexpected interest and had taken a lively part in discussing the lectures and papers which had been put before them.

Representatives of the various sections of the foundry trades expressed their readiness to further in every possible way the objects of the new trade society, and the following resolution was unanimously passed:—

"That this meeting of representatives of all sections of the foundry industry of Sheffield and district approves of the proposal to establish a trade technical society for the Sheffield foundry trades."

Speaking in support of the resolution, Dr. Longmuir, a Past President of the Institution of British Foundrymen, warmly welcomed the proposal, saying there was room for such a society, and especially as a means to convey to the workers in their own language, and without the use of difficult scientific terms, information on questions which were being discussed in scientific lectures and journals. From his own experience he could tell them of the excellent results that had already been effected by helping the workers to a knowledge of the why and the how of the various results which were achieved in everyday practice. He believed the movement would receive the support of all the branches of the foundry trade, as it would bring together employers and employees on a common platform to discuss their problems from their own particular point of view.

A programme of lectures and papers has been prepared for the forthcoming session. The gathering considered and approved of a list of officers for the society. These will be submitted to the first general meeting, which is to be held on October 18.

American Blast-Furnace Practice.—The rule for rating the capacities of blast furnaces adopted by the Southern Ohio Pig-Iron & Coke Association is based on the burning of a certain amount of a "base" coke in a given time (60 lbs. coke per cub. ft. of working volume in 24 hours). Starting with the idea that there is a definite rate of combustibility for a standard coke, assuming that the ore mixture contains 51.50 per cent. iron in the natural state, and arbitrarily using 1,800 lbs. of coke per ton of basic pig-iron when the fixed carbon in the coke is 90 per cent., it is a simple process to determine what any blast furnace should make under varying conditions of coke, ore mixture, and percentage of silicon in the pig-iron.

THE IMPERIAL TUBE WORKS of Stewarts & Lloyd's, Limited, Airdrie, are restarting on full time after a lengthened period of slackness.

Production of Steel Castings.*

By F. Darley.

(*Continued from page* 202.)

For the moulding of a fly-wheel, 14 ft. 4 in. dia., cast in three pieces, the arms and rim were made as two separate castings, split between each arm at the centre, thereby relieving any casting strains which may be set up in cooling. The boss is also made as a separate casting, arranged to be built in between the arms, and when bolted together these three pieces form a well-built wheel, free from any internal stresses, and safe to run at a speed of, say, 10,000 ft. per min. on the periphery. The total weight of this fly-wheel was 25 tons. This wheel was moulded in the floor and struck up by means of board and spindle. The arms were formed by cores and covered with a flat top plate.

Nozzle diaphragms as used for the Brown-Curtis design of turbine are cast in halves, machined and fitted together. The blades are made from rolled steel plate, either low-carbon mild steel or nickel steel. They are placed in the mould and cast in. Messrs. Firth's are at present experimenting with stainless steel blades, and the writer has every confidence that they will be a success, and will show a great advantage on account of a much longer life through being non-corrosive, and at the same time reducing the difficulty which exists with ordinary blades owing to their liability to fuse during casting. Additionally, the contraction takes place very irregularly, causing slight variation in the width of the nozzles, and sometimes buckling the blades slightly. In spite of these many difficulties, the writer has made a fair number of these castings successfully.

Stainless Steel Castings.

A new branch in the steel-casting industry, to which the writer is looking forward and hoping to make a success, is the manufacture of stainless steel castings. Already the writer's firm has made some rather intricate castings up to 10 cwts. successfully. Probably the greatest demand will be for castings from a few pounds upwards, such as internal parts for valves, acid or chemical pumps, or any purpose where corrosion or high temperatures are a serious matter. In the near future it may be used extensively for screw propellers.

This steel, in the form of castings, has a tensile of about 50 tons per sq. in., with about 12 per cent. elongation, and 90 per cent. bend. The difficulty and the peculiarity of stainless steel is that it is not stainless until it is specially heat-treated and the outer surface freed from all oxidising matter. This can be done, and the successful commercial production of stainless castings will, in the near future, be an accomplished fact. This steel, as is generally known, was first discovered in the Brown-Firth Research Laboratory, and is made extensively in the Firth works.

Large hydraulic shear standards, two of which form a pair of large bloom shears capable of cutting hot blooms 15 in. by 30 in., and are 17 ft. high and weigh 25 tons each, are moulded from a complete pattern in the floor. After the pattern is drawn the mould is finished and dried, and the cores which form the internal parts there are over 40 in number. This is a very difficult casting to make on account of the varying thicknesses and cross ribs which make it liable to pull to pieces in cooling.

Engine Wheel Centres.

In the early days of casting engine wheel-centres there were many failures. The castings were allowed to cool in the moulds, but when they were taken out and examined they were very often found to be either broken or pulled to pieces. Later the moulds were released, the wheels taken out soon after they were cast; but in spite of every precaution about 75 per cent. were either piped or pulled, and when they did come out of the mould whole they rarely went through the annealing and drop test successfully. The difficulty was eventually overcome by altering the quality and composition of the steel and by regulating the refractory material to suit the different thicknesses, while to-day it is pleasing to note that it is seldom that a waster wheel-centre is made. Two wheels were recently taken at random by the inspector and broken up for destruction test. They stood flattening and buckling up again before they could be broken, and when they were finally broken by means of a tup, all the fractures were perfectly solid, which alone proves the great improvements that have been made during the last few years in this class of casting. The reason why steel castings are so much more difficult to deal with than iron castings is that iron is much more fluid and easier to run, and the contraction of cast iron is only one-tenth of an inch per foot, while steel suitable for magnets 5/32, ordinary carbon steel 7/32, and manganese steel 9/32 per foot contraction is the cause of pulling, piping and clinking. A pull takes place when the casting is cooling from the fluid to the solid, say, at a plastic stage, and nearly always in the thickest parts which are generally opposite to a rib or bracket on account of this part either not being properly fed or being the last part to freeze, is too weak to resist the contraction which begins to take place immediately after the job is cast. The writer's opinion is that a casting will not pull after it has cooled below 800 deg. C.

Piping.

This also is the result of contraction. Taking an ordinary ingot cast either in a sand or iron mould, no matter whether it is fed from the bottom or top, it will pipe anything from 15 to 30 per cent. of its length, unless some artificial means are adopted to keep it hot at the top, until the main part has solidified. This is done sometimes by means of a fireclay nozzle placed in the top of the mould. If the top of an open ingot mould is examined a few minutes after it is cast it will be seen that it begins to contract or sink at once. What happens is that the steel, which comes in contact with the sides of the mould, freezes first and fixes into shape, while the centre part is still fluid or pasty, and will continue to feed down by gravity as long as there is any fluidity left. The metal always clings to the outer walls of the ingot, leaving a cavity from the top, down the centre of the ingot. Therefore, seeing the difficulty experienced in making a solid ingot, one can imagine that it is much more difficult to make a solid steel casting of large area and of irregular thickness.

Clinking.

Clinking or flying, this also is caused by uneven contraction and irregular cooling. Castings that are liable to clink are large spur wheels in back, or fly wheels, over 7 ft. dia., with rim arms and boss cast in one piece, unless they are split in the boss to allow freedom in contraction. A press crosshead, broke across on account of the outside cooling and contracting first and setting up a compression on the internal ribs and boss, which would keep hot some time after the outside has cooled and consequently finished contracting, and when the inside eventually cools a tension is set up on the centre arms and ribs, which is resisted by the outside. So much so that a smart blow with a hammer, or a bump, will often cause one or more of the arms or ribs to break.

Blow Holes.

Another difficulty which has not yet been entirely overcome are blow or gas holes in castings. There are several causes for this. One is insufficient venting of the mould to allow the accumulated gases to escape, which means that the gases are trapped in the mould so that the fluid steel will flow over it and trap it, and so cause blow holes

* A Paper read before the Newcastle and Sheffield Branches of the Institution of British Foundrymen.

wherever there is a particle of gas or air covered by the molten steel. Another cause is through the mould not being thoroughly dried, which causes steam to generate so soon as the hot metal comes in contact with the damp mould, which will sometimes blow out a quantity of the molten metal. A third cause of blow holes is through the steel not being properly "killed" or finished in the melting, which makes the metal "wild" when it comes in contact with the mould, so much so that it will not lie in the mould, and rises in the head similar to a cauliflower. It is then one mass of blow holes under the skin, and should be all scrap. Another frequent cause is on account of the steel not being fluid or hot enough to drive out the gases which accumulate in the mould. Therefore, given a perfectly constructed mould, and steel of the correct quality and temperature, there should not be much difficulty in this direction. Keeping large castings to their correct shape during casting and annealing requires some careful consideration. Take, for instance, a ship's stern frame or shaft brackets and the like, which are anything from 10 to 30 ft., and in some cases longer. These castings very rarely come out of the mould to the required shape, owing to contraction resistance, which is of a definite quantity. The correct way is to so construct the patterns as to anticipate the expected deformity, but sometimes the castings are deformed in the opposite sense. Plant must then be provided to correct them, after they are fettled, either by local heating and bending by means of weights or jacks, or during annealing, which is really the more scientific way. First, the job is measured, and where and how much it is out of shape noted and marked. The casting is placed in the furnace and packed up very carefully, allowing for any high places in the packing, and put weights on so that when the job gets hot the weights will bring it down to the correct line of the packing, and it will remain there until it is quite cold. Should the job be out in such a position that it is not practical to bring it to shape by means of weights, again find out where the fault is, and, if practical, which depends entirely on the shape of the job, apply the clamp method in the furnace, as explained in the case of closing in the turbine cylinder, or heat locally and bend to shape either by a hydraulic jack or screw chains, and anneal afterwards. The author has not yet encountered a casting that he has not been able to bring into shape by some means.

The Annealing of Castings.

All steel castings should be annealed to break down the casting-structures which cannot be removed except by reheating. The temperature varies according to the analysis. Carbon steel from 0.20 to 0.35 required 830 to 870 deg. C.; from 0.35 to 0.50 per cent. should be from 750 to 800 deg. C. Intricate castings of unequal thickness require very careful handling on account of the casting stresses which are set up during cooling; therefore, they must be reheated very carefully so as to maintain an even temperature, and when the required temperature is reached it should be held long enough to ensure that it is even throughout. Generally about 1½ hours is allowed per inch of thickness, after which the source of heat should be shut off and the furnace sealed up and left until quite cold. The danger point for a casting breaking or clinking is below 100 deg. C., very rarely before. When castings are all small and plain, work such as deck fittings, small railway work, pipes, small valves and general work, the castings can be heated up quickly, and once the satisfactory temperature is reached and maintained sufficiently long to soak through, they may be cooled down quite quickly, or in some cases may be pulled out of the furnace whilst hot, and no harm will be done once the casting-structure is removed.

The art of steel founding has made much progress during the last eight or ten years. To-day, there are large and intricate castings made successfully which very few foundries would care to attempt, say, ten years or so ago.

It would be better if the designer would consult the practical foundryman with regard to maintaining a fairly even thickness, avoiding thick metal in corners and diagonal ribs where possible, which often cause them to contract at cross purposes, which is liable either to put the casting in tension or to break it.

There are very few jobs, either large or small, which to-day cannot be made successfully as steel castings, if adequately studied. When made and cast in a practical manner, and properly heat-treated, they will give tests and working results equal in some respect to forgings made in similar material.

The Changes of Volume of Steels during Heat Treatment.

I.—Air Hardening Nickel-Chromium Steels.

By LESLIE AITCHISON, D.Met., B.Sc., and GEORGE REGINALD WOODVINE.

(*Summary.*)

Emphasising the importance of the alterations of volume that take place during the heating and cooling of the metal in the heat treatment of steel, the authors explain that it has been their intention to make some investigation of these critical volume changes, more particularly in respect to the more complex steels that are used so generally by modern engineers. The first series of tests have been carried out upon air-hardening nickel-chromium steels, chosen mainly because one of the authors has been engaged for some time upon an investigation of such steels, and particularly the changes that are produced in their mechanical properties when they are tempered at comparatively low temperatures. The physical changes undergone by air-hardening nickel-chromium steels at various tempering temperatures have formed a considerable part of the investigations in question, and the volume changes really formed one branch of the work. Having gone so far it was desirable that the examination of this type of steel should be continued, and as a result the work was extended further than might otherwise have been the case. It is felt that the results that have been obtained up to the present are of sufficient interest to warrant their publication (as an initial instalment) before the whole scheme of work has been brought to completion, and also possibly before the time is ripe for an attempt to give a complete explanation of the observed phenomena.

The eleven experiments made up to the present and described in the Paper may be summarised as demonstrating the following results:—

(1) That the expansion that should be produced at the critical range during the cooling from the hardening temperature is not completed during the slow cooling employed.

(2) That reheating to quite low temperatures induces a further expansion.

(3) That further reheating to low temperatures brings about a contraction.

(4) That prolonged heating at low temperatures induces still further contraction.

(5) That reheating to intermediate temperatures (300 to 500 deg. C.) induces a similar initial expansion and then a contraction.

(6) That reheating to 600 deg. C. induces a contraction.

(7) That the smaller initial expansion at the intermediate temperatures is likely to be the resultant of the expansion and contraction proceeding simultaneously.

(8) That the total contraction brought about at temperatures up to 200 deg. C. by repeated heating and cooling is less than that similarly produced at higher temperatures.

(9) That the maximum contraction brought about in any way at all the different temperatures is the same in amount.

This work is proceeding, and it is hoped that further reports may be presented in the near future, when an explanation of the observations and their practical bearings may be attempted.

MR. VICTOR STOBIE, of Dunston-on-Tyne, has recently transferred his membership from the Sheffield to the Newcastle Branch of the Institution of British Foundrymen.

Trade Talk.

ALEXANDER PETERS & COMPANY, LIMITED, nut and bolt manufacturers, have removed from North Claremont Street, to 35, Robertson Street, Glasgow.

J. J. THOMPSON & SONS, iron and steel and metal merchants, of 3, York Street, Manchester, have established a branch at 47, Exchange Buildings, Birmingham.

F. GILES & SONS, brassfounders, of 117, Scholefield Street, Birmingham, have appointed Grant-Chater, Limited, Traders' Bank Building, Toronto, as their Canadian agents.

F. W. WOODMAN & COMPANY, of 597, Sneinton Hill, Nottingham, have acquired the stock and patterns of the British Engineering & Electrical Company, Langford Street, Leek.

THE METROPOLITAN CARRIAGE, WAGON & FINANCE COMPANY, LIMITED, have secured the orders for 448 covered goods wagons for the Burma Railways and 270 ballast wagons for the South Indian Railway.

MR. A. C. MEYJES and Mr. R. F. Jones have established themselves in business at 55, Avenue Chambers, Southampton Row, London, W.C.1, as consulting engineers and agents, under the style of Charles Fennessy & Company.

DEVELOPMENTS are projected at the Gowanbank Iron Works, Falkirk. Plans have been passed and an early start will be made to reconstruct property at the works which was destroyed by fire.

H. C. SIDDENS & COMPANY, LIMITED, iron and steel merchants, of 77-82, Exchange Buildings, Birmingham, have established a London branch at 157, Palmerston House, 34, Old Broad Street, E.C.2.

THE imports of foreign iron ore at the Senhouse Dock at Maryport last month amounted to 3,800 tons, compared with 4,000 tons for the previous month. Last week 4,000 tons were imported.

THE CONSOLIDATED PNEUMATIC TOOL COMPANY, LIMITED, Egyptian House, 170, Piccadilly, London, W.1, have been appointed British and European agents for the Duff Manufacturing Company.

THE TOTAL OUTPUT of the Sunderland shipyards for the eight months of the present year is 19 vessels, aggregating 85,948 tons gross, compared with 15 vessels and 78,202 gross tons in the corresponding months of last year. The output for the first eight months of 1920 was 44 vessels and 201,143 gross tons.

CLAYTON WAGONS, LIMITED, of Lincoln, have secured a contract for 25 bogie rail and timber wagons for the metre-gauge lines of the Assam-Bengal Railway, 25 bogie rail wagons for the London and South-Western Railway, eight bogie passenger carriages for the Caledonian Railway, two bogie sleeping carriages for the Buenos Aires Midland Railway and five bogie carriage underframes and two four-wheeled carriage underframes for the Bengal-Nagpur Railway.

THE METHODS of the Disposal Board, which have lately been severely criticised by Rownson, Drew and Clydesdale, Limited, have now been brought to the notice of the Chancellor of the Exchequer as "Trustee of the public purse." In their letter to Sir Robert Horne, the company summarise their charges as below :—"(1) That the Disposal Board are involving the country in paying us approximately £50,000 compensation by refusing to give us that work for which we contracted, and to do which they are, in addition, keeping alive, at a heavy public expense, Disposal Board sections. (2) That the Disposal Board have sold at £24 6s. 8d., involving a loss of £1,500,000. quantities of brass on September 28, 1921, when they were aware that we had a contract in existence by which they were entitled to £35 per ton. (3) That the loss, based on contracts we held in March, 1921, of which the Disposal Board was fully aware, amounted to £3,600,000. (4) They in fact waited until it touched lowest, and then sold to the British Metals Corporation. (5) That quantities of other materials and stores which should have been sold by us, so avoiding compensation, have been retained by Disposal Board sections, so keeping up their sales returns as a justification for their continued existence. (6) That the sales by them have been thereby in competition with our own sales made on Disposal Board account, so losing heavily to the State. (7) That their system being chaotic, stores have not been dealt with for months and sometimes years after they have been available, many millions having been lost to the country. (8) That the Disposal Board can, by a commercial system which we are prepared to place before any committee of independent business men, at once save at least half a million sterling on existing estimates, and can, in addition, to all reasonable intents and purposes, be closed down within six months. It may be deemed that so far as charges Nos. 1, 2, 3, 4, 5, 6, and 7 are concerned, covering as they do losses already made, there is time for these to be investigated as Parliament wills. This, however, is not the case with charge No. 8, which deals with expenditure that can forthwith be avoided."

Company News.

James Joiner & Sons, Limited, Soudley, Newnham, Glos.—Capital £7,200 in £1 shares. Engineers.

Robert Crust, Limited, Bradford.—Capital £1,000. Electrical engineers. Directors: R. Crust, S. W. Hill and W. A. Toppin.

Cammell, Laird & Company, Limited.—Interim dividend, 2½ per cent., less tax, on 5 per cent. cumulative preference shares; no interim on ordinary.

Midland Shipbuilding & Trading Company, Limited, 10, Lime Street, London, E.C.3.—Capital £1,000 in £1 shares. Directors: E. E. Samuelsen, Karl Johansgate and A. V. Agius.

R. Kemp & Company, Limited.—Capital £15,000 in £1 shares (14,000 perference and 1,000 ordinary). Ship repairers. Permanent directors: Lt.-Com. A. H. J. Hamilton, Mrs. L. Hamilton, and R. Kemp.

Robinson & Nicholls, Limited, Loretto Wharf, Thames Road, Chiswick.—Capital £1,000. Founders, mechanical, electrical and general engineers, etc. Permanent directors: L. H. Robinson and H. Nicholls.

Ibbotson Brothers & Company, Limited.—Profit, £27,670; brought forward, £61,303; available surplus, £74,941; final dividend, 6s. per share for half-year ended June last (making 10 per cent. tax free for year); carried forward, £67,936.

John Simpkin, Limited, 18, Netherhall Road, Doncaster.—Capital £5,000 in £1 shares. Scrap merchants, spring manufacturers, etc. Directors: J. Simpkin, E. H. Shaw, J. H. M. Humble, J. Humble, C. G. Ramskir, and I. Woodhouse. Secretary: I. Woodhouse.

Hardy Patent Pick Company, Limited.—Brought forward, £15,483; net profit, £9,027; total, £24,510; preference dividend 7 per cent. for year; ordinary dividend 7 per cent. for year; depreciation of plant, etc., £5,000; depreciation of tools and patterns, £1,000; carry forward, £9,860.

Fletcher, Son & Fearnall, Limited.—Final ordinary dividend, 5 per cent., free of tax, making 10 per cent. for year; maintenance of premises and plant, £6,622; depreciation, £2,432; Government taxes, £29,035; investments depreciation reserve, £3,635; carried forward, £41,902.

Short Brothers, Limited, Pallion, Durham.—Capital £300,000 in £10 shares (15,000 preference and 15,000 ordinary), to acquire the shipyard and certain of the assets of, and to adopt an agreement with, Short Brothers, Limited. Permanent director and chairman: T. S. Short. Secretary: E. W. Short.

Elliott's Metal Company, Limited.—Profit, £82,225; brought forward, £23,349; available, £105,574; preference dividend, 5 per cent. per annum, less tax, £11,261; ordinary dividend, 3s. per shares, less tax (interim dividend, £22,149 already paid), £66,448; proportion of expenses of fusion with Muntz's Metal Company, Limited, £1,000; carry forward, £26,865.

Deaths.

MR. CHARLES GODFREY PHILLIPS, who met his death as the result of an accident while staying at Llandrindod Wells, was the eldest son of the late Mr. Charles D. Phillips, The Gaer, Newport. He was 48 years of age, and was educated at Christ Church, Brecon. Upon the death of his father, in October, 1912, he became joint manager of the large engineering business founded by his father under the style of Charles D. Phillips, Emlyn Engineering Works and Foundry, Newport, Mon., and continued to act in that capacity until a few months ago.

MR. RONALD LAIRD was found dead at his residence in Oxton on September 4, having been overcome by gas fumes. The deceased was at business on the previous day. As a young man, Mr. Ronald Laird did not enjoy robust health, and shortly after finishing his education he had to spend some years in the South of England. Returning North, he commenced his business career, and in November, 1915, was appointed to succeed the late Mr. James Burton as Liverpool representative of Cammell, Laird & Company, Limited. He was a direct descendant of the late Mr. John Laird, founder of the firm.

MR. J. AMOS LLOYD, managing director of John Brotherton, Limited, Wolverhampton, died on September 2 at his residence at Compton, near Wolverhampton. The late Mr. J. Amos Lloyd, who came of an old Staffordshire family, was born at Pelsall in 1860. An early business training in the iron and steel trades fitted him for a secretarial position, which he took up at John Brotherton, Limited, Wolverhampton, thirty years ago. From secretary he rose to managing director, and was actively engaged in business until about a month ago. He became a member of the Council of the Wolverhampton Chamber of Commerce in 1901, and he was made president in 1906. From 1916-1919 he was again elected president, and was a member of the executive council since 1917.

IRON AND STEEL MARKETS.

Pig-iron.

Markets all round during the week just closed appeared to have recovered some degree of firmness, and with an under-current of renewed activity the outlook may certainly be claimed as more encouraging than has been experienced for some time past. This improvement, however, cannot be attributed to an expansion of home demand, which continues of disappointing volume, but may probably be credited to an increase of exports of pig consequent upon domestic industrial troubles in the United States, where the miners' and railwaymen's disputes have caused a temporary suspension of iron furnace outputs. So far, Midland ironmasters have not been so much affected by these conditions, but the demand for export iron in the North-East and Scottish markets has enabled some of the Derbyshire and South Staffordshire makers to dispose of surplus stock on fairly favourable terms. The difficulty in the latter markets is that buyers continue to restrict their purchases to comparatively small parcels for immediate requirements, very few transactions on forward account being reported. Some indication of the more hopeful prospect for the trade is found in preparations now going forward for increased production, additional furnaces being re-lighted in some of the principal centres of the industry.

In the Tees-side area the feature of the market is the advance in prices of Cleveland iron in consequence of the American orders. Compared with normal times, of course, these orders are not heavy, but coming at a time when production has been limited to the smallest possible, it has naturally created some scarcity of iron, and the better qualities are now practically unprocurable for prompt delivery. Values have accordingly been advanced by at least 2s. 6d. per ton, but this can only be of a temporary character and dependent upon the length of the American demand. Consequently at last week's market prompt iron was unobtainable, and No. 3 quality was strong at 90s., or 2s. 6d. above the previous week's figure. For No. 1 and silicious, which have been extremely scarce for a long time past, 97s. 6d. was named, and No. 4 foundry advanced to 87s. 6d., No. 4 forge being about 85s., and mottled and white 80s. to 82s.

In the Cumberland and North Lancashire hematite pig-iron market, there is at last some prospect of an additional furnace or two being lighted. Only nine furnaces—six in Cumberland and three in North Lancashire—are now blowing. But the make is being fully absorbed, and, what is more, the stocks lying in the works' yards are being fast depleted. Competition here is exceedingly keen, and the quotation of Bessemer mixed numbers at £5 5s. per ton delivered at Glasgow and Sheffield is only nominal. In actual fact, the price is a few shillings below that figure, and thus the prediction that iron would fall to £4 10s. per ton at works before winter has come true. In the North-East Coast market the general level of business has been better. Iron is being got away in moderate lots to Wales and the Continent, and one or two makers have been helped by sales to America. At last week's market sellers developed a rather firmer attitude, the majority declining to name less than 90s. for East Coast mixed numbers. But there was still a possibility of shading this figure for substantial business. The premium for No. 1 stands at 6d. per ton.

The August shipments from Middlesbrough (including 2,513 tons from Skinningrove) amounted to 37,972 tons, compared with 35,426 tons in July, an increase of 2,546 tons. Shipments to the United States were again an outstanding feature, amounting to 9,862 tons, as against 5,825 tons in July, an increase of 4,037 tons. Italy was the next largest buyer with 4,023 tons, as against 4,470 tons. Belgium took 3,096 tons, Germany 2,680 tons, France 1,420 tons, Denmark 1,276 tons, and B.W. Indies 1,000 tons. Coastwise, 5,060 tons went to South Wales and 3,050 tons to Scotland.

Finished Iron.

The markets for finished materials, although better attended of late, do not as yet reflect any striking improvement in general business, due it must be assumed to the uncertainty of price movements, and a lack of confidence as to the trend of future demand on the part of buyers, both at home and abroad. In the South Staffordshire area there are still many works standing idle, or only partially employed, and there seems little prospect of an improvement in this direction until manufacturers' overhead costs can be reduced. Among the chief contributory factors in this connection is unquestionably the high cost of rail transport for both raw and finished material, which inflicts a heavy handicap on Midland iron manufacturers, who find themselves at a serious disadvantage

(*Continued on page* 230.)

MACHINERY.

(*Continued from page 18.*)

FOR SALE.

Three nearly new 24-in. Centres, All-Geared Head, arranged for motor drive S.S.S. Lathes, on 36-ft. bed, by G. & A. Harvey, Ltd. Ten nearly new 18-in. Centres, All-Geared Head, arranged for motor drive S S.S. Lathes, on 34 ft. 3 in. bed, by G. & A. Harvey, Ltd. 10/12-in. stroke Slotting Machine, by J. Butler & Co. High-speed Planing Machine, to plane 4 ft. 0 in. x 1 ft. 6 in. x 1 ft. 6 in., by C. Redman & Sons. Heavy Duty High-speed Planing Machine, to plane 8 ft. x 3 ft. x 3 ft., two tool boxes on cross slide, by J. Butler & Co. Vertical Boring and Turning Mill, with 50-in. table, two tool boxes on cross slide, by the Bridgeport Machine Tool Works, Ltd. Horizontal Boring Machine, by Noble & Lund. T-slotted table, 3 ft. 6 in. x 3 ft. 6in. 32-in. Swing Gisholt Combination Capstan Lathe, with 32-in. geared three-jaw chuck. Two Twin Spindle Vertical Boring, Drilling and Tapping Machines, by D. & J. Tullis; 2¼-in. spindle, working surface of table 5 ft. 6 in. x 4 ft. 0 in. Horizontal Boring Machine, by the Lucas Machine Tool Co., Ltd.; 3-in. spindle, T-slotted table, 3 ft. 6 in. x 1 ft. 10 in.

Catalogue of Stock Machinery, 5-6,000 Lots.
Free on Application. Inspection Invited.

THOS. W. WARD, LTD.,
ALBION WORKS,
SHEFFIELD.

FOUNDRY SAND MIXERS (three), never been used, for 1, 2 and 4 tons per hour; clearance prices.—Box 158, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

NEW WELDING PLANT, with Acetylene Generator, six blowpipes, etc., ready for use, £17 5s.; complete new Cutting Plant, £15 10s. Lists free.—STANSELL'S ACETYLENE COMPANY, LIMITED, Exeter.

ONE 20-in. CENTRIFUGAL FOUNDRY SAND MIXER, capacity 1 to 2 tons per hour, fitted with latest improvements and equal to new.—Price and particulars on application to C. E. V. HALL, 26, Paradise Square, Sheffield.

PATENT.

ADVICE and Handbook Free.—KING'S PATENT AGENCY, LIMITED, Director, B. T. King, Reg. Patent Agent, 146a, Queen Victoria Street, E.C.4.

MISCELLANEOUS.

PENCIL GANISTER, of high quality, and other grades for Sale.—Apply, R. E. ADAMSON, Ushaw Moor, County Durham.

FOUNDRY BUSINESS FOR SALE by private treaty (owing to the retirement of the owner). An old-established Foundry and Engineering Business in an important Midland town, including the Freehold Premises, Goodwill, Machinery and Stock-in-Trade.—For further particulars, apply to E. IRWIN MILLER, Esq., Solicitor, Bridge Street, Walsall.

S. G. SMITH,
Iron Foundry Expert,

Late Foundry Specialist with Metropolitan Vickers Electrical Company, Limited, Trafford Park, Manchester,

Is again available for consultations, investigations, and advice on all matters appertaining to Iron Foundries and Castings.

Upwards of 40 years' active experience of work of all classes.

Author of Articles covering Modern Foundry Practice, including

Foundry Lay-out and Design,
Cast Iron, Analysis and Mixings for Various Castings,
Cupola Practice and Management,
Moulding and Facing Sands, Blackings, etc.,
Loam and Sand Procedures, etc., etc.,

Lecturer and Teacher on Foundry Processes at the College of Technology, Manchester.

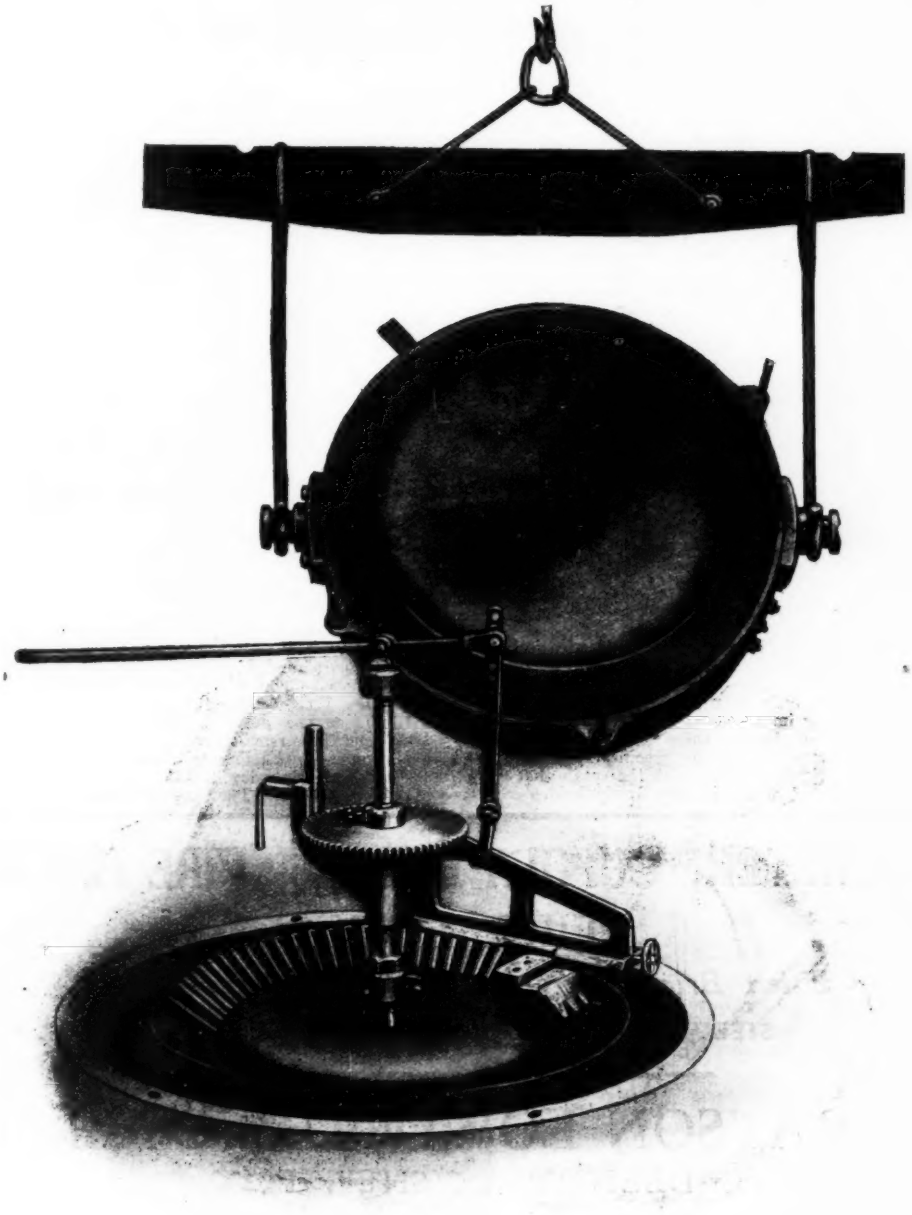
Practical Tuition to Foundry Students, private, or in classes; also Universities, Colleges, and Technical Schools.

Consultations, away or at home, by appointment.

Terms, reasonable and satisfactory.

The "VULCANIA" PATENT WHEEL MOULDING MACHINE.

Patent No. 5049.



THE "VULCANIA" PATENT WHEEL MOULDING MACHINE is for moulding spur wheels with straight, sloping or Vee-shaped teeth, also bevel wheels, skew gear wheels, worm wheels and internal wheels. The machine head is carried on a pillar which is held in a base-plate bedded in the floor sand, and is made to slide on the pillar by means of a lever and link carried on a joint bearing, or by rack and pinion, or screw if thought advisable for the particular work it is being used for.

An adjustable stop collar is provided for accurately deciding the depth of mould. On the removable head a slide is carried for supporting the patterns of the teeth to be moulded. This slide is made adjustable by screw or pinion gearing to the diameter required. The number of teeth to be moulded is decided by a special dividing plate into which a steel wedge or finger engages. The special dividing plate has milled vees, at the angle of 60° inclusive, around its circumference, to receive the steel wedge, which is adjusted by a screw having an internal spring to keep it in tension and to lock the head when ramming operations are being carried out.

JAMES EVANS & CO., BRITANNIA WORKS,

(MANCHESTER), LIMITED.

BLACKFRIARS, MANCHESTER.

IRON AND STEEL MARKETS.—*Cont. from page 228.*

in competing for export business with producers having seaboard facilities. In the bar-iron section makers of marked qualities report an average demand, but with only limited forward buying, owing, it is surmised, to an erroneous impression that a further reduction in values is imminent. A similar idea appears to prevail with regard to crown bars, for which £10 12s. 6d. is quoted, although it is understood that that price is unremunerative. Nut and bolt qualities are only in moderate demand at about previous rates, while inquiries for gas strip are by no means up to the usual average.

Steel.

Conditions in many branches of the steel trade continue to make slow but steady progress towards recovery from the recent depression, and it is generally admitted that the influx of orders and inquiries is coming in satisfactory volume. At Sheffield the outstanding feature is the call for the cheaper classes of steel, in which local manufacturers are able to compete with Continental producers. For high-speed and other high-class steels there is scarcely any inquiry, and such requirement as there is is mostly met from surplus war stocks. Basic billets are selling fairly freely, but acid qualities are very quiet. Indications of the strength or weakness of the steel industry are also to be found in the position of the ferro-alloy market, from which is learnt that while the demand for ferro-chrome in all grades has been more brisk, prices on the whole have not tended to hardening, and it would appear the demand is mainly for immediate requirements and does not point to any forward business. Ferro-silicon has been stagnant, whilst most of the other alloys have been more or less dormant.

Scrap.

Corresponding conditions to those already outlined in the pig-iron trade are evidenced in the markets for scrap, and although the volume of business reported is only comparatively small, the demand all round indicates a steady improvement in consumptive requirements. At Middlesbrough there is some shortage of heavy steel scrap to suitable specifications, and a steady demand is developing, with the result that 65s. per ton delivered works is now firmly held. Steel turnings and c.i. borings are also scarce, and realise 48s. to 49s. per ton delivered.

Metals.

Copper.—During the past week values for standard metal have been at consistent strength, and in trade circles the opinion is expressed that prices should maintain their present levels over, at all events, the end of the quarter. Evidence favouring this view is the resumption of influential support, withheld from the market for some time past, while the consumptive demand at home and on the Continent also shows an improvement. Current quotations :—*Cash* : Wednesday, £63; Thursday, £63 2s. 6d.; Friday, £63 2s. 6d.; Monday, £63; Tuesday, £63 2s. 6d. *Three Months* : Wednesday, £63 7s. 6d.; Thursday, £63 10s.; Friday, £63 10s.; Monday, £63 7s. 6d.; Tuesday, £63 10s.

Tin.—Home consumers' demands of late have been by no means brisk, but there has been a fair volume of speculative dealings in standard tin, while support for the market has also been forthcoming from America, where the tinplate trade is active. The usual monthly statistics for August show an increase in the visible supplies, but although this was anticipated, the excess was not expected to amount to such a large tonnage. Sentiment, however, has not been greatly affected thereby. Meanwhile the East has sold fair quantities at prices following the London market. Quotations for 65 per cent. Bolivian ores range from £93 to £95 per ton. Current quotations :—*Cash* : Wednesday, £159 10s.; Thursday, £159 15s.; Friday, £159 12s. 6d.; Monday, £159 5s.; Tuesday, £158 12s. 6d. *Three Months* : Wednesday, £163 7s. 6d.; Thursday, £160 5s.; Friday, £160 2s. 6d.; Monday, £159 15s.; Tuesday, £159 10s.

Spelter.—Some fluctuations in values of this metal have been noted of late, but these have been confined in a narrow range, and the market generally has been fairly steady. Current quotations :—*Ordinary* : Wednesday, £31 7s. 6d.; Thursday, £31 7s. 6d.; Friday, £31 10s.; Monday, £31 10s.; Tuesday, £31 10s.

Lead.—With some improvement in home consumptive demand, soft foreign pig has been firm and steady, with values held at recent levels. Stocks of lead on September 1 are returned at 686 tons, an increase of 451 tons on the previous month's total, but at the same time these remain practically negligible. Current quotations :—*Soft foreign (prompt)* : Wednesday, £24 12s. 6d.; Thursday, £24 12s. 6d.; Friday, £24 10s.; Monday, £24 10s.; Tuesday, £24 10s.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,
FIRE CLAY.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
STEEL MOULDERS' COMPOSITION, SILICA CEMENT.
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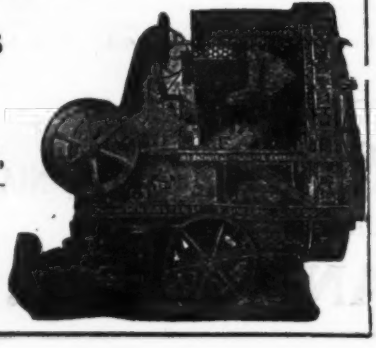

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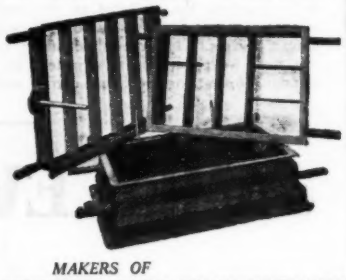
Improved Sliding Bar for Foundry Flasks.
Patent applied for.



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TO ANY SPECIFICATION.
See DETAILED ADVERTISEMENT Next Week.

Telephone: 21, Penistone. Telegrams: "Durranns, Penistone."

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JAS. DURRANS & SONS., LTD.

Phoenix Works, Penistone NEAR SHEFFIELD.

BLACKING
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CORE GUM
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Manufacturers of

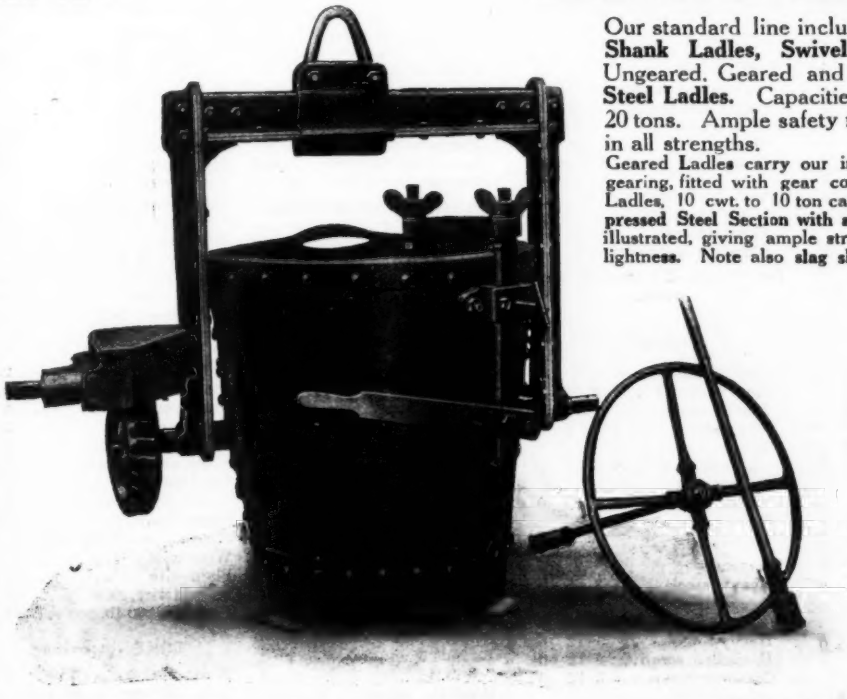
FOUNDRY EQUIPMENTS.

Ladles, Cupolas, Fire Bricks, Ganister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Write for illustrated catalogue on Blacking and Foundry Requisites, also for our latest Price List.

You Get Exceptional Efficiency, Economy and Service when you use our—

LADLES



Our standard line includes Pressed Steel **Shank Ladles, Swivel Tilting, Bogie,** Ungeared, Geared and **Bottom Pouring Steel Ladles.** Capacities from 28lbs. to 20 tons. Ample safety margin is allowed in all strengths.

Geared Ladles carry our improved worm type gearing, fitted with gear covers. Bail of Crane Ladles, 10 cwt. to 10 ton capacity, is of **improved pressed Steel Section with adjustable shackle,** as illustrated, giving ample strength combined with lightness. Note also **slag skimming device.**—We also manufacture **Improved Rapid Melting Cupolas** of any size, **Charging Devices and Platforms,** etc. We Build and completely Equip Foundries all over the world. Constructural Steel Work of every description.

May we send you full details.

Contractors to British, French and Belgian Governments.

The Constructional Engineering Co. Ltd.

Titan Works
Charles Henry Street, Birmingham, England.

WEEKLY PRICE CURRENT.

COPPER.

	£	s	d.
Standard cash	63	2	6
Three months	63	10	0
Electrolytic	70	15	0
Tough	65	15	0
Best selected	65	15	0
Sheets	94	0	0
India	84	0	0
Wire bars	71	0	0
Do. Oct.	71	0	0
Do. Nov.	71	0	0
Ingot bars	71	0	0
H.C. wire rods	76	5	0
Off. aver. cash, Aug.	63	16	9 2/11
Do. 3 mths., Aug.	63	19	2 5/11
Do. Settlement Aug.	63	16	11 9/11
Do. Electro, Aug.	70	8	7 7/11
Do. B.S., Aug.	67	6	8
Aver. spot price, copper, Aug.	63	16	1½
Do. Electro, Aug.	70	18	7½

Solid drawn tubes 13½d.
Brazed tubes 13½d.
Wire 10½d.
Yellow metal rods 6½d.
Do. 4x4 Squares 8½d.
Do. 4x3 Sheets 9½d

BRASS.

Solid drawn tubes 11½d.
Brazed tubes 13½d
Rods, drawn 10½d.
Rods, extruded or rolled 6½d.
Sheets to 10 w.g. 10d.
Wire 9½d.
Rolled metal 9½d.

TIN.

Standard cash	158	12	6
Three Months	159	10	0
English	158	0	0
Bars	160	0	0
Chinese	157	2	6
Straits	159	2	6
Australian	159	15	0
Eastern	161	15	0
Banca	158	15	0
Off. aver. cash, Aug.	160	1	0 4/11
Do. 3 mths., Aug.	160	3	4 10/11
Do. Sttlment. Aug.	160	1	7 3/11
Aver. spot, Aug.	160	0	5½

SPELTER.

Ordinary	31	10	0
Remelted	30	0	0
Hard	23	10	0
Electro 99.9	34	7	6
English	31	15	0
India	24	0	0
Prime Western	31	12	6
Zinc dust	48	0	0
Zinc ashes	9	0	0
Off. aver., Aug.	30	16	3
Aver., spot, Aug.	31	3	5

LEAD.

Soft foreign ppt	24	10	0
English	25	10	0
Off. average, Aug.	24	3	10 4/11
Average spot, Aug.	24	11	8½

ZINC SHEETS.

Zinc sheets, English	37	10	0
Do. V.M. ex. whf.	38	10	0
Dutch	38	0	0
Rods	42	0	0
Boiler plates	35	10	0
Battery plates	36	0	0

ANTIMONY.

English regulus	25	15	0
Special brands	32	10	0
Chinese	23	10	0
Crude	14	15	0

QUICKSILVER.

Quicksilver 12 15 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—
45/50% 12 5 0
75% 21 10 0
Ferro-vanadium—
35/40% 17/6 lb. va.
Ferro-molybdenum—
70/75% 7/9 lb. mo.
Ferro-titanium—
23/25%, carbonless 1/2 lb.
Ferro-phosphorus, 20/23%, £20
Ferro-tungsten—
80/85%, carbon free 1/6 lb.
Tungsten metal powder—
98/99% 1/9½ lb.
Ferro-chrome—
4/6% car. £23 0
6/8% car. £22 10
8/10% car. £22 0
Ferro-chrome—
Max. 2% car. £60
Max. 1% car. £68
Max. 0.70% car. £75
67/70%, carbonless 1/6½ lb.
Nickel—99%, cubes or pellets £150
Cobalt metal—98/99% 11/- lb.
Aluminium—98/99% £100
Metallic Chromium—
96/98% 5/- lb.
Ferro-manganese (net)—
76/80%, loose £15
76/80%, packed £16
76/80%, export £14 10
Metallic manganese—
94/96%, carbonless 2/4 lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	2	6
Finished bars, 18% tungsten	3	0

Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Flats under 1 in. by ¾ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness 3d. lb.
Bevels of approved sizes and sections 6d. lb.
If in coils 3d. lb.
Packing £3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces 3d.
Turnings and swarf 1d.
Per lb. net, d/d steel makers' works.

SCRAP.

	£	s.	d.
South Wales—Heavy Steel	3	7	6
	3	12	6
Bundled steel & shearings	2	17	0
	3	5	0
Mixed iron & steel	2	17	6
	3	2	6
Heavy cast iron	3	5	0
	3	15	0
Good machinery for foundries	4	0	0
Cleveland—Heavy steel	3	5	0
Steel turnings	2	8	6
Cast-iron borings	2	8	6
Heavy forge	3	12	6
Bushelled scrap	2	12	6
Cast-iron scrap	3	12	6
Lancashire—Cast iron scrap	3	17	6
Heavy wrought	3	7	6
Steel turnings	2	2	6
London—Copper (clean)	56	0	0
Brass (clean)	30	0	0
Lead (less usual draft)	21	0	0
Tea lead	18	0	0
Zinc	17	0	0
New aluminium cuttings	60	0	0
Braziery copper	46	0	0
Gun metal	40	0	0
Hollow pewter	125	0	0
Shaped black pewter	80	0	0

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—Foundry No. 1	97/6
Foundry No. 3	90/-
Forge No. 4	87/6
Mottled	81/-
Hematite No. 1	90/6
Hematite M/Nos.	90/-
Midlands—Staffs. common	—
„ part-mine forge	—
„ „ foundry	—
„ Cold blast	240/-
„ basic	—
Northants forge 70/- to	72/6
„ foundry No. 3 77/6 „	80/-
„ basic	82/6
Derbyshire forge	75/-
„ foundry No. 3	82/6
„ basic	80/-
Scotland—Foundry No. 1	106/6
„ No. 3	101/6
Hematite M/Nos.	107/6
Sheffield (d/d district)—Derby forge	82/6
„ foundry No. 3	86/6
„ basic	—
Lincs. forge	86/6
„ foundry No. 3	86/6
„ basic	86/6
E.C. hematite	101/-
W.C. hematite	102/6

All d/d in the district.

Lancashire (d/d eq. Man.)—Derby forge	—
„ foundry No. 3	92/6
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
„ foundry No. 3	—
Summerlee foundry	116/6
Glengarnock foundry	118/6
Gartsherrie foundry	118/6
Monkland foundry	116/6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (cr.)	£10 10 to 11	10	0
Angles	£11 to 11	10	0
Tees to 3 united ins.	£11 10 to 12	0	0
Nut and bolt	9	17	6
Hoops	14	0	0
Marked bars (Staffs.)	13	10	0
Gas strip	11	0	0
Bolts and nuts, ¾ in. × 4 in.	18	10	0
Steel— Ship plates	£9 to 9	10	0
Boiler plates	12	10	0
Chequer plates	10	10	0
Angles	£8 12 6 to 8	17	6
Tees	£9 12 6 to 9	17	6
Channels	8	10	0
Joists	9	0	0
Rounds & squares 3-in. to 5¼in.	10	0	0
Rounds, under 3in. to ¼in.	9	10	0
Flats, over 5in. wide and up	10	0	0
Flats 5in. to 1¼in.	8	10	0
Rails, heavy	8	15	0
Fishplates	14	10	0
Hoops	11	10	0
Black sheets, 24 g.	12	0	0
Galv. cor. sheets, 24 g.	16	10	0
Galv. fencing wire, 8 g. plain	16	0	0
Rivets, ¾ in. dia	13	0	0
Billets, soft 7 0 0 to 7	5	0	
Billets, hard	8	0	0
Sheet bars 6 17 6 to 7	7	6	

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 3
Sheet	1 3½
Wire	1 3½
Rods	1 2½
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.
CHARLES CLIFFORD & SON LIMITED, BIRMINGHAM.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	11d. to 1/5
Rolled— To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5½ to 1/11½
To 15 in. wide	1/6 to 2/0
To 18 in. wide	1/6½ to 2/0½
To 21 in. wide	1/7½ to 2/1½
To 25 in. wide	1/8½ to 2/2½
Ingots for spoons and forks	11d. to 1/5
Ingots rolled to spoon size	1/2 to 1/8
Wire round— 3/0 to 10. G.	1/8½ to 2/3½

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	34.14
No. 2 foundry Valley	33.00
No. 2 foundry, Birm.	23.00
Basic	31.96
Bessemer	33.76
Malleable	34.96
Grey forge	34.76
Ferro-manganese 80 % delivered	70.82
Bess. rails, h'y, at mill	40.00
O.-h. rails, h'y, at mill	40.00
Bess. billets	38.00
O.-h. billets	38.00
O.-h. sheet bars	38.00
Wire rods	45.00
	Cents.
Iron bars, Phila.	2.32
Steel bars	2.00
Tank plates	2.00
Beams, etc.	2.00
Skelp, grooved steel	2.00
Skelp, sheared steel	2.00
Steel hoops	2.75
Sheets, black, No. 28	3.35
Sheets, galv., No. 28	4.35
Sheets, blue an'l'd, 9&10	2.50
Wire nails	2.60
Plain wire	2.35
Barbed wire, galv.	3.15
Tinplate, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	35/- to 40/-
„ furnace	30/- to 32/6
Durham & North. foundry	28/-
„ furnace	23/6
Other Districts, foundry	27/6
„ furnace	22/6

SWEDISH IRON.

Bars, hammered basis sizes Basis price £22 to £23

	£ s. d.
Rolled Ordinary— Assortment ..	17 0 0
Nail Rods— Square, round and flats ..	to 17 10 0

Keg Steel nom. £38 to £40
Faggot Steel nom. £30 to £32

Blooms—
Single welded .. £10 to £11

Billets—
Single and double welded £13 to £14

Pig-Iron—
Grey, white or mottled .. £7 to £7 10 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

Up to and incl. 6 in.

Gas	.. 55%	Tube prices are now free.
Water	.. 50%	
Steam	.. 45%	

TINPLATES.

I.C.Cokes,	20×14, box		19/3
,,	28×20,	,,	38/6
,,	20×10,	,,	28/-
,,	18¾×14,	,,	19/7½
I.X.		,,	44/-
I.X.X.		,,	51/-
F.C.B.Y.	21×13⅝	,,	37/-
C.V.B.G.	16¾×15,	,,	35/6
I.C.W.	20×14,	,,	17/-
,,	28×20,	,,	33/9
,,	20×10,	,,	23/3
,,	18¾×14,	,,	17/3
Ternepiates,	28×20,	,,	34/3

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.	
Sept. 6	63	0	0	No change
,, 7	63	2	6	inc. 2/6
,, 8	63	2	6	No change
,, 11	63	0	0	dec. 2/6
,, 12	63	2	6	inc. 2/6

Electrolytic Copper.

Sept. 6	70	10	0	inc. 5/-
,, 7	70	10	0	No change
,, 8	70	15	0	inc. 5/-
,, 11	70	15	0	No change
,, 12	70	15	0	,,

Standard Tin (cash).

Sept. 6	159	10	0	No change
,, 7	159	15	0	inc. 5/-
,, 8	159	12	6	dec. 2/6
,, 11	159	5	0	,, 7/6
,, 12	158	12	6	,, 12/6

Tin (English ingots)

Sept. 6	159	0	0	No change
,, 7	159	5	0	inc. 5/-
,, 8	159	2	6	dec. 2/6
,, 11	158	15	0	,, 7/6
,, 12	158	0	0	,, 15/-

Zinc Sheets (English)

Sept. 6	37	10	0	No change
,, 7	37	10	0	,,
,, 8	37	10	0	,,
,, 11	37	10	0	,,
,, 12	37	10	0	,,

Spelter (ordinary).

Sept. 6	31	7	6	inc. 2/6
,, 7	31	7	6	No change
,, 8	31	10	0	inc. 2/6
,, 11	31	10	0	No change
,, 12	31	10	0	,,

Lead (English).

Sept. 6	25	10	0	No change
,, 7	25	10	0	,,
,, 8	25	10	0	,,
,, 11	25	10	0	,,
,, 12	25	10	0	,,

We manufacture and can supply immediately

LOW GRADE

FERRO SILICON

8/10% 10/12% 12/15% and 20/25%.

THE NEWCASTLE ALLOY CO., LTD.,
Milburn House,
Newcastle-on-Tyne.

Telephone: 800 CITY (7 lines).
Telegrams: ALLOY, NEWCASTLE-ON-TYNE.

GIVE THE BRITISH MANUFACTURER FIRST CHANCE.

SHROPSHIRE IRON Co., Ltd.

Works:—
Hadley, Shropshire.

London: 10, Bush Lane, Cannon St., E.C.4.

Telegrams:—
Sun, Wellington, Salop.
Sunbrand (Cannon), London.

Telephones:—
11 Wellington, Salop.
5959 Central.

BARS, HOOPS, SECTIONS & WIRE
in IRON, STEEL, COPPER and BRONZE.

Galvanised Telegraph, Telephone, Cable and Trolley Wire
To all Specifications.

Contractors to H.M. Government (Admiralty, G.P.O., India Office, War Office, Colonies), English and Foreign Railways, &c.

BEST H. C. COPPER & BRONZE WIRE a speciality.

Medals:—Sydney (Bronze) 1879, New Zealand (Gold) 1882, Liverpool (Silver) 1886, Adelaide (Gold) 1887, Franco-British Grand Prix (Highest Award) 1908.

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT
5, MURZBAN ROAD, BOMBAY.
1, LALL BAZAR CALCUTTA.

REGISTERED TRADE MARK

1, HONG KONG ROAD, SHANGHAI.
31, RAFFLES PLACE, SINGAPORE.
JAVA STREET, KUALA LUMPUR.
5 SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.

PIG IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

FOUNDRY COKE

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,

ROYAL EXCHANGE, MIDDLESBROUGH.

93, HOPE STREET, GLASGOW.

SITUATIONS VACANT AND WANTED.

MOULDER REQUIRES STEADY AND PROGRESSIVE JOB. Accustomed to complete control. Motor and General Engineer and Jobbing. Personally operating Cupola and other Furnaces, making oil-sand jacket cores, and supplying castings to analysis. Iron, Aluminium and Bronze. Good Technical and Practical: Mathematics, Mechanics, Chemistry, Physics, Metallurgy, Iron and Steel Manager and Mechanical Drawing. Good knowledge of costs, and could assist in Drawing Office, Pattern Shop or any department of Foundry. I.B.F. and B.C.I.R.A. Man. — Apply: F. A., c/o Ignition Laboratory, 57, Union Street, Oldham, Lancs.

ADVERTISER, Age 39, seeks position as Non-ferrous FOUNDRY MANAGER. Twenty-five years' practical experience. Thorough knowledge of up-to-date plant and practice. Unimpeachable references. Address, in first instance, Box 212, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

FOUNDRY FOREMAN for Iron Foundry (Herts), employing 40 hands. High-class General Castings (medium weight). Applicants must have held similar position and possess sound references as to organising ability and economic working.—State age and wages required to Box 250, Offices of THE FOUNDRY TRADE JOURNAL, 5, Duke Street, Adelphi, London, W.C.2.

TENDERS.

RENFREW.

IRON FOUNDRY AND SMELTING WORKS FOR SALE.

FOR SALE, the IRON FOUNDRY and SMELTING WORKS belonging to A. MACAULAY & COMPANY, LIMITED, RENFREW, now in Liquidation :—

1. The Iron Foundry, having a frontage to Brown Street, Renfrew, consists of :—
   Main Foundry Building, Mechanics' Shop, Dressers' Shed, Bogie Rail Track, Plant and Machinery, etc. Electric Light Installation.
   Extent of ground, 1 acre or thereby. Feu duty, £23 0s. 5d. Casualties redeemed.
2. The Smelting Works, having a frontage to French Street, Renfrew, of about 162 feet, consist of :—
   Main Building forming Smelting Works, Melting Furnaces, Plant and Machinery, Offices, Store, Washhouse, Petrol Store and Tanks.
   Extent of ground, 1 acre, 2 poles, 19 square yards, or thereby. Feu duty, £18 17s. 6d. Casualties redeemed.

Offers marked "Tenders for Macaulay's Iron Foundry and Smelting Works" are invited for both Works, or for each Work separately, and should be lodged with the Liquidator, R. H. Ballantine, C.A., 116, Hope Street, Glasgow, not later than Wednesday, September 27, 1922.

For further particulars and cards to view, apply to J. Wyllie Guild and Ballantine, C.A., 116, Hope Street, Glasgow, or to Anderson Fyfe Littlejohn & Company, Solicitors, 201, West George Street, Glasgow.

CITY OF HULL.

TRAMWAY RAILS.

The Corporation are prepared to receive Tenders for the supply of 500 or 1,000 Tons TRAMWAY RAILS, 112 lbs. to the yard, Hull section (centre groove), together with 30 Tons FISHPLATES.

Also for the purchase of about 300 Tons OLD RAILS, to be taken up during the ensuing six months.

Forms of Tender and other particulars may be obtained of the undersigned.

Forms for the supply of Rails will only be furnished to actual manufacturers or their accredited agents.

Tenders, endorsed as directed on the Forms of Tender, are to be addressed to the Chairman of the Tramways Sub-Committee and delivered at the Town Clerk's Office before noon on WEDNESDAY, the 27th September.

The Corporation do not bind themselves to accept any Tender.

By Order,
F. W. BRICKNELL,
City Engineer.

31st August, 1922.

GALVANISED Iron or Steel Tubular Poles for Telegraph Poles, 20 ft. long, 1,500, Schedule 755. Tenders are invited by the Commonwealth of Australia for the above, receivable in Australia on 15th November.—For tender, forms, and full particulars, apply SUPPLY OFFICER, Room 101, Australia House, Strand, London, W.C.2.

TENDERS (*continued*).

NATIONAL GAS COUNCIL OF GREAT BRITAIN AND IRELAND.

Gas Cooking Stoves.

FOR the purpose of enabling Standard Cookers, manufactured according to specifications approved by the National Gas Council, to be purchased by the Gas Industry, the Council is prepared to receive tenders for the supply of the following :—

(1) One set of lead master patterns for each of two sizes of stove, viz., No. 2 (unpacked) and No. 3 (packed), in accordance with drawings and specifications to be supplied by the Council.

(2) Sets of original Cast Iron patterns for each size of stove.

(3) One set of master jigs for each size of stove.

(4) 12 specimen cookers of each of the above sizes in accordance with drawings and specifications to be supplied by the Council.

(5) Complete Base Stands (two sizes, viz., 4 in. and 24 in. high) in accordance with drawings and specifications to be supplied by the Council.

(6) One set of lead master patterns for each size of stand.

(7) Sets of Cast Iron patterns for each size of stand.

(8) Complete plate racks (including back plate) in accordance with drawings to be supplied by the manufacturer and to the general specification of the Council.

NOTE.—To enable them to adjudicate between the different tenders submitted, the Council reserve to themselves the right to require detailed working drawings of all the above patterns and jigs, if they think fit.

Firms willing and able to supply are invited to apply in writing as soon as possible, but in any event not later than October 4, 1922, to the undersigned, for the necessary drawings, specifications, forms of tender and of contract conditions, which will be forwarded upon payment of a fee of £25, which fee will be returned in cases where a bonâ fide tender is duly made.

The Council does not bind itself to accept the lowest or any tender.

W. J. SMITH.
Secretary.

NATIONAL GAS COUNCIL OF GT. BRITAIN AND IRELAND,
30, Grosvenor Gardens, London, S.W.1.
September 11, 1922.

MACHINERY.

FOR SALE.—One No. 6 Thwaites Rapid Cupola, with drop bottom, complete with charging and cleaning doors in new condition, equal in every respect to new.—Price, £125, f.o.r., Keighley.

Two No. 6 Keith Blackman High Pressure Motor-driven Fans, complete with starters, etc., suitable for 400 volts, 50 periods, 65 amps., 12-in. delivery, 3-phase A.C.—Price, £125 each, f.o.r., Keighley.—Apply, Box 246, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, Strand, London, W.C.2.

CUPOLAS! CUPOLAS!! CUPOLAS!!!—Fifteen Riveted Steel Cylinders, as new, 18 ft. x 2 ft. 6 in.; would make excellent Cupolas, complete with Steel Girder Framework Pipes and Air Ducts; £300 the lot, f.o.r. Details, Drawings.—HARRY H. GARDAM & COMPANY, LIMITED, Staines.

CUPOLAS

30-in. ALLDAY'S CUPOLA with hoist, staging, 20ft. by 10ft. and roof, complete installation £150 f.o.r., standing in London.

42-in. WHITING CUPOLA, with spark arrester, staging hoist, etc., ready for immediate use, and complete in every detail, £380 f.o.r. London, for the entire plant, including 3 phase, 50 cycle, 415 volt electric hoist, and electric blower, same voltage.

URGENTLY REQUIRED

2-ton stock oil-fired converter. Two small tilting cupolettes. Also **all kinds** of surplus foundry plant **for re-sale.** Please send offers to—

ALEXANDER HAMMOND,
Foundry Machinery Merchant,
"BOXTED," SLOUGH.

Small Advertisements continued on page 228.